ENGINEERING LIBRARY
MAY 2 0 1947

ARMY ORDNANCE

VOL. XXXI, No. 162

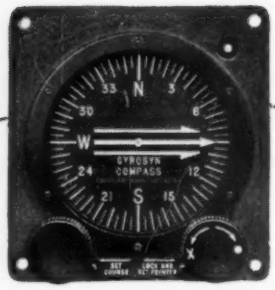
MAY-JUNE, 1947

IN THIS ISSUE

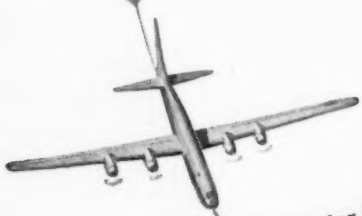
GENERAL CARL SPAATZ
"Our new frontier is up"

★

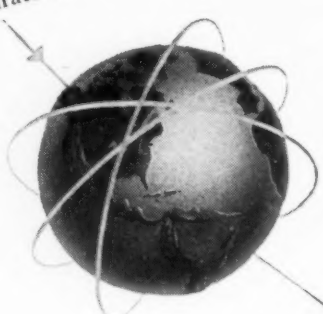
REVIEW OF INDUSTRIAL
PAREDNESS FOR NATIONAL
ENSE PUBLISHED BY THE
Y ORDNANCE ASSOCIA-
N, WASHINGTON, D. C.



The Sperry Gyrosyn Compass . . .
is a stable directional indicator under
all conditions of air turbulence.
It does not oscillate, swing or
have northerly turning error.



. . . that facilitates Polar Navigation . . .
for the Gyrosyn Compass indicates magnetic
heading accurately even when the horizontal
component of the earth's magnetic field is very
low. In polar regions where magnetic heading
is difficult to use for steering, the Gyrosyn Compass
may be used as an accurate directional gyro.



. . . can chart new Air Avenues for you . . .
You can be sure of your heading . . .
with the Sperry Gyrosyn Compass.
Flight records from leading airlines
credit this instrument with over 5,000
air hours without need of any maintenance.

AND IN THE MARINE FIELD, Sperry Radar and Loran, are piloting ships on safer, shorter courses through every kind of weather.

Sperry Gyroscope Company, Inc.

EXECUTIVE OFFICES: GREAT NECK, NEW YORK • DIVISION OF THE SPERRY CORPORATION
LOS ANGELES • SAN FRANCISCO • SEATTLE • NEW ORLEANS • CLEVELAND • HONOLU

ARMY ORDNANCE was entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Copyright 1947 by the Army Ordnance Association, publisher, 705 Mil's Buildi Washington 6, D.C. Issued bimonthly. Single copy, 75¢ (by mail). Subscr tion rate: U. S. and possessions, $4.50 annually, in advance; foreign, $5.

Why NICKEL Alloy Steels Are Specified for Giant Generator Shafts

Alloy steel containing two and a half percent Nickel along with small percentages of other alloying elements give the heavy sections of this turbine rotor shaft the strength, toughness and endurance so vital to dependable performance. A yield strength of 80,000 p.s.i. combined with reduction of area consistently exceeding 36% in both radial and transverse directions was achieved in this heavy section.

PHOTO COURTESY OF GENERAL ELECTRIC CO.

HEADED FOR THE LARGEST TURBO-GENERATOR OF ITS TYPE IN THE WORLD

This 75,000 pound Nickel alloy steel rotor shaft will serve in a new record size turbine generator rated at 100,000 KW, 77 feet long, 17 feet wide and designed for inlet conditions of 1250 p.s.i. and 1000° F.

INCO Nickel

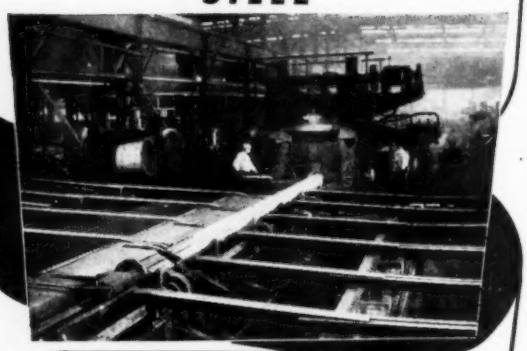
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of eng neering steels, stainless steels, cast irons, brasses, bronzes and other alloys containing Nickel. This information and data are yours for the asking. Write for "List A" of available publications.

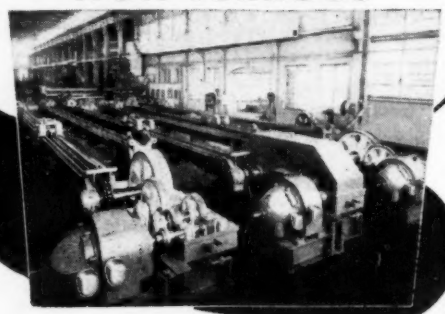
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

Designers and Builders to the

STEEL



NON-FERROUS



AND OTHER INDUSTRIES

PLASTIC
RUBBER
CHEMICAL
FOOD
RAILROAD
OIL
MANY OTHERS

The

AETNA-STANDARD ENGINEERING CO.

YOUNGSTOWN, OHIO

ARMY E NAVY

ASSOCIATED COMPANY:
HEAD, WRIGHTSON & COMPANY, LIMITED
MIDDLESBROUGH, ENGLAND

Communications

REPORT ON RADIOACTIVE MINERALS

THE EDITOR.—The March-April issue of ARMY ORDNANCE as well as your Bulletin No. 75 referred to the reported finding of thorium and uranium in ilmenite deposits in Howard County, Arkansas. Samples from the deposit have since been tested by three laboratories, all of which gave a negative report on the presence of radioactive minerals. The following official statement gives the facts of the case.

"In October 1946, a highly exaggerated report regarding the content of uranium and thorium in the Howard County ilmenite deposits was circulated by both national press and radio. Since monazite, a thorium-bearing mineral, is a common associate of ilmenite in the beach-sand type of deposit, it was considered advisable to check the samples collected earlier by our own survey from the Howard County deposits for the presence of radioactive elements.

"Microscopic examination by Geologist Drew F. Holbrook of the State Survey of samples of the ilmenite-bearing sands from this locality, however, failed to disclose any monazite. As a further check on this possibility, cuts of all the samples previously described in this report were sent to three reliable laboratories for examination. Thorough tests were made on these samples utilizing both the Geiger-Müeller counter and chemical analysis.

"Two samples—No. 718, a composite of the channel samples from the road cut on the Pink Green property, and No. 717, a composite of the samples from the auger hole on the Beulah Green property—were analyzed by the Charles O. Parker Company of Denver, Colo., with the following results, dated December 9, 1946:

" 'Sample No. 717: Radioactive elements, none; qualitative for uranium and thorium show negative. Sample No. 718: Radioactive elements, none; qualitative for uranium and thorium show negative.'

"Since these and other tests failed to indicate the presence of radioactive elements in the samples, it is reasonable to assume that the report was unfounded and that the ilmenite deposits cannot be considered a source of uranium and thorium minerals."

We trust that you will correct your previous accounts for the sake of the good name of Arkansas.

HAROLD B. FOXHALL
Director, Arkansas Resources and Development Commission

Little Rock, Ark.

■ **Dr. Gustav Egloff, director of research of the Universal Products Company, speaking before the American Chemical Society recently, said that uranium is one of several by-products obtained in producing oil from shale in Sweden. The shale is radioactive and contains nearly half a pound of uranium oxide per ton, he said.—Editor.**

THAT PARIS "MYSTERY"

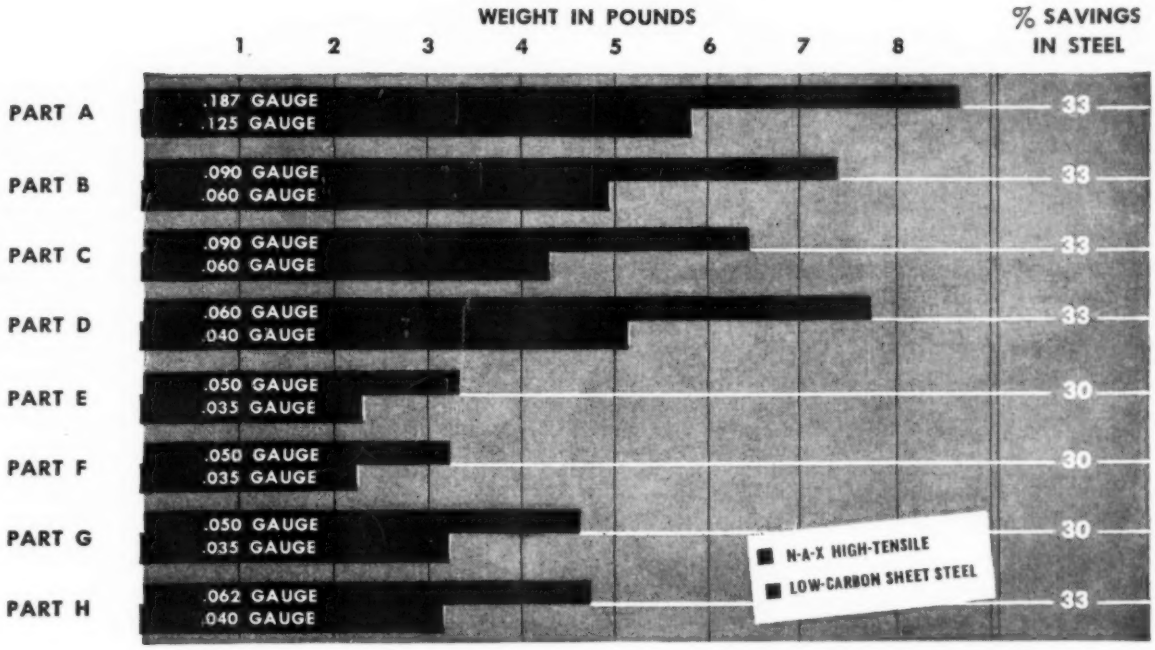
THE EDITOR.—After reading "The Great Paris Mystery" in a recent issue of ARMY ORDNANCE, I could not resist writing you to tell you that I could have solved the mystery very promptly. I have on my dresser a matched pair of 37-mm. cartridge cases with "tulip-bulb" mouths that I picked out of thousands in 1922.

When I was chairman of the Salvage Board, we had a salvaging operation going on at the Delaware Depot, and I hap-

THE NEW ARITHMETIC IN STEEL

ACTUAL PRODUCTION FIGURES MORE THAN PROVE IT:

3 TONS N-A-X HIGH-TENSILE > 4 TONS CARBON SHEET STEEL



We have claimed that N-A-X HIGH-TENSILE can effect a 25% saving in steel. This graph shows the results when one leading manufacturer switched from carbon steel sheets to N-A-X HIGH-TENSILE . . . utilized thinner sections with no sacrifice of strength . . . and saved up to 33% in steel.

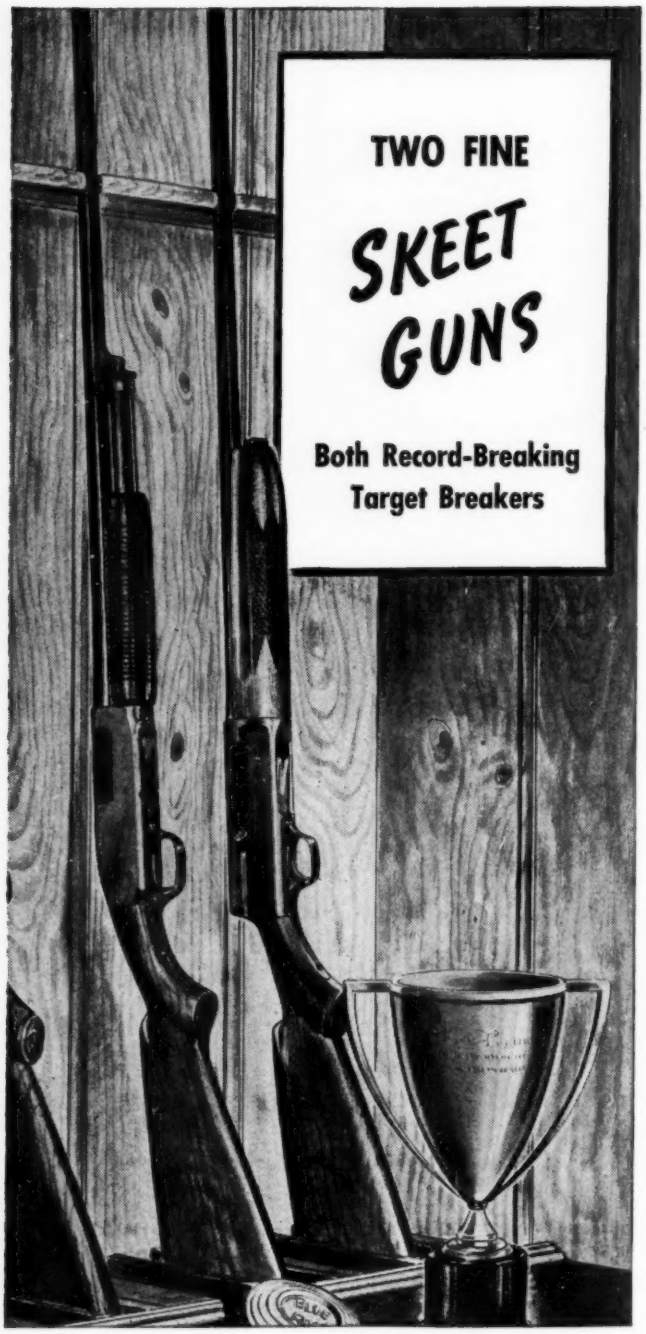
The change was made because of the unique combination of properties of N-A-X HIGH-TENSILE. With its 50% higher physical properties, it has exceptional formability for a high-strength steel, and can be formed and drawn into intricate shapes with little or no change in dies or machinery adjustments. It has excellent weldability, great impact toughness, high fatigue- and corrosion-resistance. These qualities not only provide a more durable product, but often effect economies in fabricating and handling. Based on *over-all costs*, N-A-X HIGH-TENSILE compares favorably with carbon sheet steel.

Today's supply of N-A-X HIGH-TENSILE is insufficient to meet the demand, but we are looking forward to the day when we can fill your needs. When that time comes, our engineers and metallurgists will be glad to work with you to determine just how much steel you can save by using N-A-X HIGH-TENSILE.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N-A-X
HIGH-TENSILE STEEL

COPYRIGHT 1948
GREAT LAKES STEEL CORP.

GREAT LAKES STEEL
Corporation
N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
UNIT OF NATIONAL STEEL CORPORATION



Whether you prefer an autoloader or a pump gun, you'll find a Remington the *right* gun. The Remington Model 31 (left) pump-action, repeating shotgun was nicknamed "the gun with the 'ball-bearing' action" by aerial gunnery students, because of its velvety-smooth operation. On the right is the Remington Sportsman, a 3-shot autoloader—points as naturally as your finger.

Keep an eye on the high gun shooters at tournaments. Notice how many of them win with Remingtons. For FREE literature, write Remington Arms Company, Inc., Bridgeport 2, Conn.

Remington

DUPONT

"If It's Remington—It's Right!"

Sportsman is Reg. U. S. Pat. Off. by Remington Arms Company, Inc.

pened to be there when a big pile of complete rounds of ammunition awaiting breakdown caught fire. The heat from the burning boxes ignited the smokeless powder, and the internal pressure created broke the cases loose from the shells. However, the pressures built up to the point where the thinner forward portion of the cases, where the crimping was good, practically all expanded.

It was surprising to find the uniformity of deformation, indicating uniformity of wall thickness and anneal in these cases. It took place without regard to what was in the shell itself. The interesting sidelight was that to the best of our knowledge no single shell exploded regardless of its load, even though some of them were heated so hot that they would burn their way into wood. It all goes to show that explosives are tricky.

COL. C. R. BAXTER

Chicago, Ill.

THE EDITOR.—The writer has seen cases similar to that described in "The Great Paris Mystery." During a wartime test of tank fire causes, live ammunition was subjected to intense heat or to actual fire while in various racks or bins as used in tanks. During these tests a number of 37-mm. cases were observed to have reacted in this same manner as the "mystery case." It was believed that the powder, instead of rapidly burning as when fired in a gun, actually only reached a kindling temperature and burst into flame.

The gradually mounting pressure resulting therefrom began to push the projectile. Before it was pushed out of the case, however, the neck bulged. This was due to the tip of the projectile pressing against the top of a bin or packing box, and perhaps the neck was softer than usual. As the projectile moved forward, it gradually relieved the pressure then building up in the case. The gases undoubtedly "whistled" out. Powder will burn relatively slowly unless confined. When properly confined the pressure builds up rapidly.

Another "Mystery"

The incident is indeed very rare and occurs only in that split second of time between the exploding of the propellant under pressure and its slower burning caused by fire around the outside of the cartridge case. A cartridge case under exterior fire conditions usually explodes with considerable violence. The case as seen in Captain Sharpe's picture is exceptionally rare due to its symmetry.

The enclosed picture illustrates the writer's similar 37-mm. case found in a burnt-out tank on the Western Desert.

COL. G. BURLING JARRETT

Aberdeen Proving Ground, Md.

THE EDITOR.—In the January-February issue of ARMY ORDNANCE, page 366, the undersigned wrote a brief comment on a peculiarly expanded 10.5-cm. Czech shell, with a photo of what became known as "The Great Paris Mystery." This peculiar phenomenon was the only example he had seen in examining thousands of ammunition dump-fire cook-offs.

It seems that this unusual and interesting shell contour acquired by a cook-off process has happened before—and probably will happen again. At least three Association members reported similar instances. I am indebted to Fred Meins of Ryegate, Mont., for reports on similar cases found at Ilu River, Guadalcanal, in the cook-offs of our 75-mm. howitzer M48 with high-explosive shell in the cloverleaf package. He also reported finding one caliber .30 rifle round with a bulbous expansion in the rear of

To this screen, April 7, 1927, came the first pictures by long-distance television

IMPORTANT BELL SYSTEM DATES IN TELEVISION

APRIL 7, 1927 First transmission of television over wire circuit, Washington, D. C., to New York City, and by radio from Whippany, N. J., to New York City.

JUNE 27, 1929 First public demonstration of color television, at Bell Telephone Laboratories, New York.

APRIL 9, 1930 Two-way television demonstrated publicly between A. T. & T. building and Bell Laboratories building in New York City.

NOV. 9, 1937 Coaxial cable first transmitted visual images for 240-line television pictures from New York City to Philadelphia.

MAY 21, 1940 441-line television transmitted over coaxial cable from New York City to Philadelphia and return.

MAY 12, 1941 441-line television transmitted over coaxial cable for a distance of about 800 miles.

AUGUST 20, 1946 A model microwave system to transmit television over a line-of-sight path was demonstrated from Hollywood to the top of Mt. Wilson.

Dr. H. E. Ives explains to guests of the American Telephone and Telegraph Company the principles of the television demonstration, made possible by himself and his associates.

"It was," said a newspaper next day, "as if a photograph had suddenly come to life and begun to smile, talk, nod its head and look this way and that."

For the first time in history, television apparatus, developed by Bell Laboratories for the Bell System, had publicly transmitted sight over a long wire and radio circuit. Large-scale images were flashed from *Whippany, N. J.*, and *Washington, D. C.*, to a public demonstration in New York City.

Television is the idea, not of one mind, but of many minds at work on the same project. At Bell Telephone Laboratories the ideas were first put together to create a successful television system.

Today our laboratories are developing television transmission facilities. The promise of things to come is bright, because the knowledge being applied is diverse, co-ordinated, and eager to advance a great art to the point of wide public usefulness.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

METALWORKING MACHINERY

Cold Headers for Bolts, Screws, etc.

Bolt Head Trimmers

Screw Thread Rolling Machines

Nut Forming Machines

Nut Tapping Machines

Screw Slotters

Rivet Drillers

Power Presses of all Kinds

Eyelet Machines

Small Arms Ammunition Machines

Collapsible Tube Machines

Thread Rolling Machines for Shells

Wire Drawing Machines

Rolling Mills for Sheets and Strips

Rod and Tube Mills

Flatteners and Straighteners

Gang Slitting Machines

Swagers, Pointers, Coilers, Winders, etc.

Special and Miscellaneous Machines

WATERBURY FARREL
FOUNDRY AND MACHINE COMPANY
Waterbury Connecticut, U. S. A.
SALES OFFICES:
CHICAGO CLEVELAND NEWARK, N. J.

the bottleneck. Other communications were received from Col. Charles R. Baxter, a former editor of ARMY ORDNANCE, and from Col. G. B. Jarrett, Chief of the Ordnance Museum at Aberdeen Proving Ground, Md.

Cook-offs are unpredictable. In artillery fixed rounds the powder burns slowly due to improper ignition. Usually the powder starts before the primer and its booster have ignited. The resultant slow ignition and combustion permit the expanding gas to push the relatively heavy projectile free, with the soft brass shell stretching at the mouth due to anneal and thin walls. Often the case will split. A study of these cook-offs clearly shows why brass cases perform such excellent obturation tasks in sealing the chamber of the weapon where it is most needed—at the mouth of the case.

PHILIP B. SHARPE

Baltimore, Md.

"DOGMATIC AND NARROW-MINDED"

THE EDITOR.—I have just been reading the February A. O. A. Business Letter contributed by E. B. Gallaher. It makes my face red to think that such dogmatic and narrow-minded argument has the endorsement of the Army Ordnance Association. As an example of what I object to, I quote the following paragraph from page 3:

> "Of course, the whole purpose of the Government during the past fourteen years has been, first, to break down our American free-enterprise system and then to take over and run the country under a controlled economy."

It is my recollection that fourteen years ago the American free-enterprise system had developed serious weaknesses, and I believe it is only fair to consider that one of the purposes of the Government at that time was to prevent further deterioration. Furthermore, in 1941 we entered upon a war, and one purpose of the Government was to win that war. Both of these purposes are wholly excluded by Mr. Gallaher.

It would also seem that one way to cure the poor position that we find ourselves in because of an enormous Government debt would be to raise some money by taxation to pay off at least a small part of that debt. Mr. Gallaher is so opposed to taxation that he never even suggests the possibility of doing this.

At the risk of being considered softheaded and a crackpot, I would like to remind Mr. Gallaher that the late Justice Oliver Wendell Holmes said: "I like to pay taxes. With them I buy civilization."

HOWARD L. KING

Port Washington, N. Y.

"IN BEHALF OF TRUTH"

THE EDITOR.—In further response to your request for an opinion as to your readers' relative preference for your publications, I would just like to add a word to the card poll.

Although we are all quite conscious of the fact that there are just too many publications these days, yours are still worthy of reading time. They contain good sound philosophy and opinions pertinent to our international policy, frankly and forcibly stated. History discloses that men and nations pay through the nose for their mistakes and that some voice was always raised in behalf of truth. There have been millions of such voices raised during these last fifteen years of folly—which still were not enough.

So in your efforts, efficiency in conversion of the indifferent and nonbelievers will be low. You can only hope to influence a few but still possibly enough to influence the results in favor of a proper policy of national preparedness. . . .

C. C. ROSE

East Cleveland, Ohio

The Approved All-Purpose Distress Signal

A-P DAYNITE DISTRESS SIGNAL

T.M. Reg. Patents Applied For

1,500,000 NOW BEING MADE FOR ARMED FORCES

Identified as SIGNAL DISTRESS DAY AND NIGHT MARK 13 MOD 0

- ★ **STANDARD** — U. S. Navy and U. S. Naval Air Force.
- ★ **STANDARD** — U. S. Marine Corps.
- ★ **APPROVED** by the U. S. Coast Guard for ships' lifeboats and life rafts.
- ★ **APPROVED** by the Civil Aeronautics Administration as replacement for Very pistol and cartridges.
- ★ **SPECIFIED** by Air Transport Association for all inflatable life rafts.
- ★ **OBSERVED** from aircraft in Official U. S. Coast Guard test—33 miles.
- ★ **OBSOLETES** pistol-projected, floating and roman-candle type signals.

Hand held. Safe. ***Each signal is absolutely watertight. Light—less than 7 oz. Compact—5⅛" long.*** 20-second brilliant night flare *plus* 20-second bright orange day smoke in opposite ends of steel container. Can be seen day or night when overcast would obscure pistol or roman-candle type signals. ***Available at all marine and aviation supply dealers. Accept no substitutes.***

AERIAL PRODUCTS, INC., MERRICK, L. I., N. Y.

FAST...SIMPLE work holding

for GRINDER, LATHE or BENCH

Here's a Rotary Chuck (9" dia.) with many unique features. Does not heat the work . . . no electricity . . . no work thrown off. Holds tightly for light cuts on lathes and on thin work for light machining. Can be clamped to bench for testing or inspection work. When you buy a ROTARY get *ALL* these and other advantages . . . buy a Brown & Sharpe.

Rectangular Models (5 sizes from $2\frac{7}{16}$" x $5\frac{1}{4}$" to $12\frac{1}{8}$" x 36") and other Permanent Magnet Holding Tools also available.

For sale only in the United States of America and its Territories. Write for catalog, Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

B·S

We urge buying through the Distributor

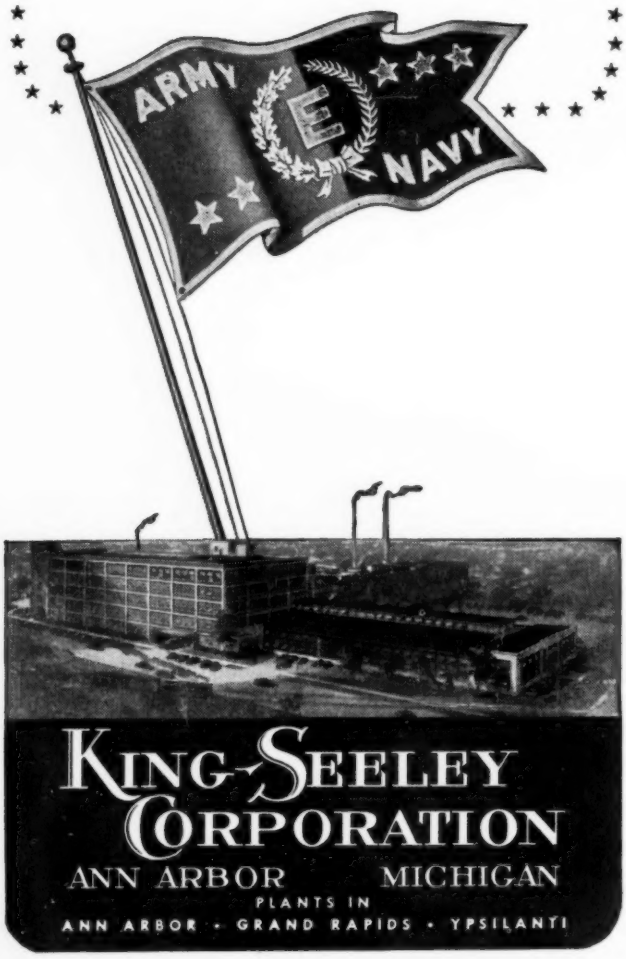
BROWN & SHARPE PERMANENT MAGNET CHUCKS

KING-SEELEY'S

Service Record

The records show that between February, 1941, and August, 1945, King-Seeley employees produced and delivered to our Armed Forces more than 385,000,000 pieces of special war materials. In addition to this, more than 1,000,000 pieces of regular production items such as governors, gauges, and speedometers for both combat and supply vehicles were produced.

We feel justly proud of this record and the sixth Army-Navy "E" Award given us May 12, 1945, in recognition of this accomplishment. If necessary, we can do it again, but right now we are devoting all our energy to the production of peacetime civilian goods to the end that all may enjoy true prosperity.



KING-SEELEY CORPORATION

ANN ARBOR MICHIGAN

PLANTS IN

ANN ARBOR • GRAND RAPIDS • YPSILANTI

Communications

THE PEABODY RIFLE

THE EDITOR.—I'm trying to obtain information about the "Peabody rifle," a breechloader introduced about 1862-1865. It was submitted to Ordnance in 1865, but though it was supposed to be one of the best, it never received any contract or other recognition. I'd appreciate any information you could give me regarding its qualities, shortcomings, or anything else pertaining to it.

LAWRENCE WHITE

Norwood, Mass.

■ **The following data, in reply to Mr. White's request, were compiled by F. W. Foster Gleason of our research staff mostly from notes taken from "Single-Shot Rifles," by James J. Grant (Wm. Morrow & Company, New York, 1947) and from "American Inventions," by Charles B. Norton (Chapin & Gould, Springfield, Mass., 1880).—Editor.**

On July 22, 1862, Patent No. 35947 was granted to Henry O. Peabody of Boston for a single-shot rifle with falling-breechblock action. The first model of the Peabody, with outside hammer, was adopted by both the U. S. Goverment and the Connecticut militia. No record seems to remain as to the number made or who made these early guns, though they were probably manufactured by the Providence Tool Company of Rhode Island, who made all the later Peabody arms.

In January 1865, a U. S. Army Board convened at Springfield, Mass., to consider adoption of a standard breech-loading rifle. The Peabody and sixty-four other guns were tested. After the most exhaustive tests, the board recommended the Peabody, but the end of the Civil War (occurring during the tests) prevented action. A second board, in 1868, also chose the Peabody, but it was decided to convert the Springfield muzzle-loading rifle, and a considerable number of these were converted, using the original Peabody action, with outside hammer. A third board, in 1870, recommended six different rifles, not including the Peabody. A fourth board that same year tested a caliber .43 Peabody, which developed grave difficulties in extracting fired shells, and tests of this rifle were discontinued.

Meanwhile, in 1868, Peabody assigned his patent to the Providence Tool Company who made all his rifles thereafter. The first model of the original Peabody was made in caliber .50/50/210 and later models in many calibers. After 1872, no original Peabody guns were made. The action had been improved by Martini, a Swiss, by substituting an inside striker for the outside hammer—speeding up both loading and ignition time. The Turkish contract for 600,000 Peabody-Martini rifles in .45/85/485 caliber took most of the Providence capacity for some years.

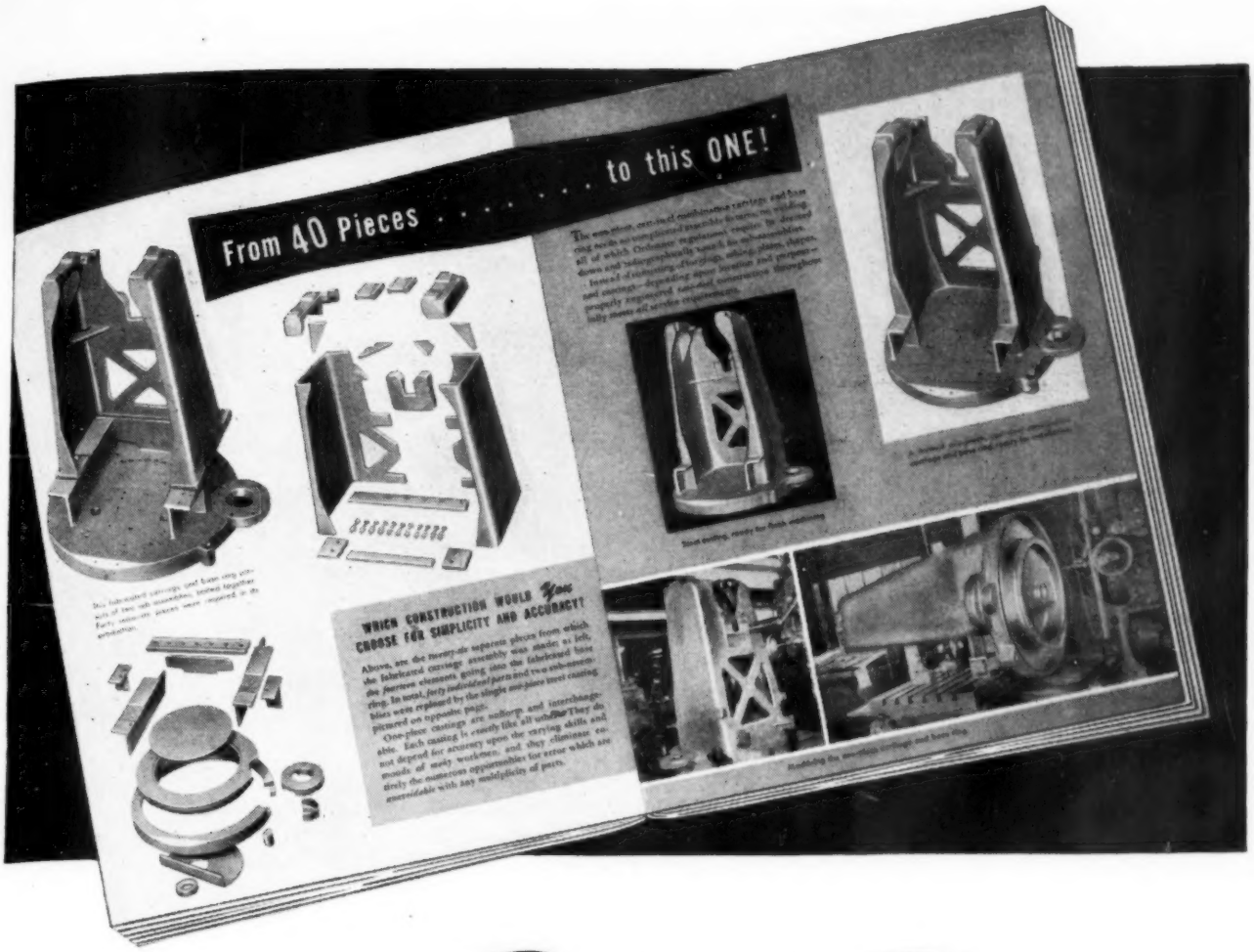
These rifles were standard in the Turkish Army during the war with Russia in 1877-1878. At the siege of Plevna, 40,000 Turks, so armed, stood off an overwhelming number of Russians armed with the Berdan breechloader and an older muzzle-loading rifle.

F. W. F. GLEASON

"MANAGEMENT STEERS THE BOAT"

THE EDITOR.—Will you kindly extend to E. B. Gallaher my compliments on his timely articles. Plant executives are kidding themselves if they think that their plants are efficient. They frankly refuse to look the truth in the eye and admit their failings. They are living along, day by day, hoping against hope that something will turn up which will smooth over the low spots. And the losses continue to pile up, and labor continues to ride high, wide, and handsome. This is no philippic against labor, because management is in the same position and is steering the boat that labor is rowing.

Larchmont, N. Y. DONALD L. KELLOGG



NEW BOOK FOR *Production Planners*

Every plant executive and design engineer can profit from this new, informative booklet—a vivid case-history of how *two* steel castings replaced three weldments composed of *sixty* different elements. It's timely—straight to the point—full of facts and figures—intended to help you get back to *fundamentals* in production planning.

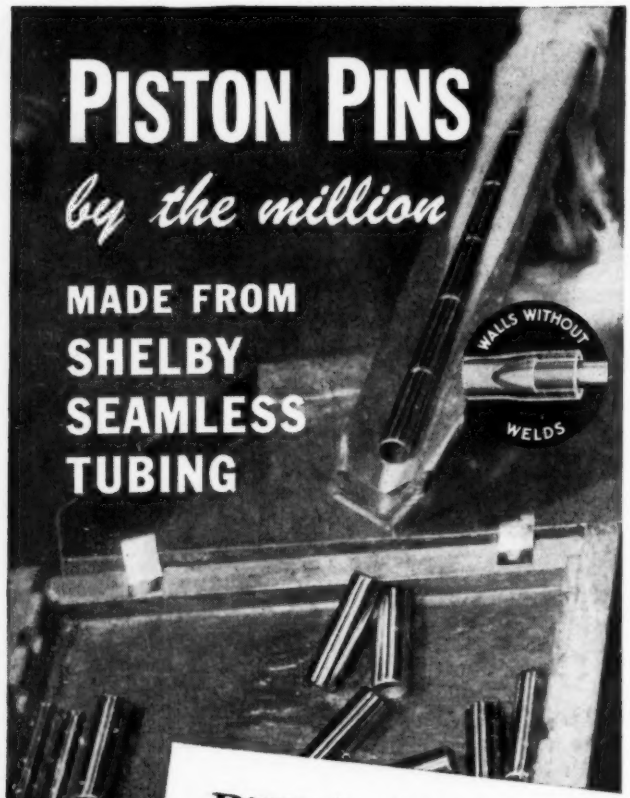
See for yourself how simplification and repetitive accuracy lower production costs . . . how metal wastage is eliminated . . . how steel castings actually *reduce* finished weights. Steel castings *minimize* purchasing problems, material inventories, stock control, and rehandling. Get the *whole* story in "This Job's Done . . . Is Yours?"

Write Today on Your Business Letterhead for This Interesting New Booklet

AMERICAN STEEL FOUNDRIES

410 NORTH MICHIGAN AVENUE • CHICAGO 11, ILLINOIS

MINT-MARK OF ⬡ FINE CAST STEEL



PISTON pins, rifle parts or any one of hundreds of tubular items can be produced quickly and accurately by using U·S·S SHELBY Seamless Steel Tubing as the basic material.

In this case, a manufacturer produced over 3½ million piston pins from SHELBY Tubing. All were interchangeable and finished to a tolerance of 1/10,000 of an inch.

For ordnance equipment, reliability and accuracy are essential—and high quality seamless steel tubing eliminates unnecessary labor and machining.

When designing new equipment or improving the old, consider the savings possible by substituting seamless tubing for boring solid stock or for forgings and castings. Our engineers and metallurgists are available to offer competent help in working out better production methods.

NATIONAL TUBE COMPANY
PITTSBURGH, PA.
Tubing Specialties Division

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

New Developments

IN THE ARMY

COLD WEATHER TESTS

The principal problems confronting the Army Ground Forces as disclosed by cold-weather tests in Alaska include the development of new vehicles—or the modification of old—which can traverse the mushy tundra, the development of adequate shelter which will withstand the winds, and the perfection of clothing which will protect against the chilling wind and rain which penetrate any small opening or unreënforced seam. The tests also seek to simplify the clothing and shelter needed to protect personnel so that the pack load of the infantryman can be reduced.

"Tundra passability," or the development of vehicles or methods for getting weapons and other matériel across the tundra, presents many major problems. The tests have shown that heavy tanks will not operate across tundra. Light tanks can be used effectively, but preliminary tests indicate that a modification of tracks will be required. It has been found that wide, low-ground-pressure tracks are required on heavy vehicles to assure gripping and holding in the loose mushy terrain.

Similar problems are presented in the use of heavy artillery. Heavy self-propelled guns have not been able to navigate the tundra effectively. Considerable success has been attained in the movement of medium artillery by placing it on sleds and dragging it with tractors equipped with low-ground-pressure tracks. In some instances the use of two of these tractors has been required to surmount slopes of twenty-five to thirty degrees when pulling a 155-mm. gun.

The weasel is the most effective all-purpose vehicle for the transportation of personnel on tundra, and the heavier buffalo, in several types, is equally effective in performance of heavier tasks.

All types of weapons function normally in the Aleutian climate, but maintenance tasks are increased by the constant hazard of rust, induced by the continuous moist or wet conditions. The climatic conditions do cause certain difficulties with ammunition, particularly that used in demolitions. The terrain necessitates the use of the air-burst technique in the employment of artillery, since ground bursts produce little or no fragmentation due to the fact that the projectile sinks into the soft tundra and fragments are absorbed and smothered.

ORDNANCE STORAGE DIFFICULTIES

After a two-week inspection tour during which he was shocked by the sight of 20,000 Army vehicles slowly rusting away at a single field, Maj. Gen. Everett S. Hughes, Chief of Ordnance, stated that the Ordnance Department is unable, because of a lack of funds, warehouse facilities, and personnel, to give proper protection and maintenance to huge numbers of all types of vehicles. It is his personal conviction, he said, that much of the matériel being stored will be either obsolete before it can be used again or will go to ruin unless it is given better protection.

The general stated that he intends to suggest to Army Ground Forces that the reserve equipment requirements be reviewed and matériel that can be dispensed with be either sold as surplus or junked.

General Hughes estimated that about one-third of the entire Ordnance Department budget was consumed by its "caretaker" responsibilities, and still the job is not being properly done.

on the record—

or on the road—

the best brake is AIR

The most satisfactory thing about Air Brakes, as an investment, is that their remarkable performance never shows up in higher costs. In fact, they pay for themselves in smoother braking, lowered maintenance costs, added payloads, and lessened driver fatigue. Whether you are looking at the problem from behind the steering wheel, or from behind the balance sheet, there can be no argument that the best brake is AIR, and the best Air Brake is Bendix-Westinghouse!

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO

BENDIX-WESTINGHOUSE AIR BRAKES

the best AIR brake is

Bendix-Westinghouse

SHEFFIELD
Products and Services

Machine Tools
Micro-form Grinders • Thread and Form Grinders
Gear Chamfering Machines • Gear Burring Machines
Special Purpose Machine Tools

Measuring Instruments
Precisionaires • Visual Gages • Electrigages
Multicheks • Electricheks
Internal and External Measuring Instruments
Thread Checking Instruments
Automatic Gaging Machines

All types of Standard and Special Precision Gages

Contract Services
Design • Manufacture • Dimensional Control Systems
Diemakers • Toolmakers
Precision Parts and Assemblies

check WITH SHEFFIELD

THE SHEFFIELD CORPORATION
Dayton 1, Ohio, U. S. A.
MACHINE TOOLS • GAGES • MEASURING INSTRUMENTS
CONTRACT SERVICES

DISSTON
TOOL STEEL

High Speed Steels
Kutkwik 6-N-6 Di-Mol

Oil Hardening Steels
Croloy Mansil Keystone Nicroman

Water Hardening Steels
Best Extra Standard

Special Steels
for Every Tool Application

Disston engineers and metallurgists will be glad to help you with any tool-steel problem that may confront you. Write.

HENRY DISSTON & SONS, INC.
Tacony, Philadelphia 35, Pa.

New Developments

Ammunition storage is another serious problem, particularly since there is a safety factor involved. It can be preserved indefinitely, but not unless it is under cover.

RESPIRATOR FOR ARCTIC CLIMATES

A device for retaining body heat exhaled with the breath in extremely cold climates has been tested by Army Ground Forces "Task Force Frigid" at Fairbanks, Alaska, and also in the Antarctic. Known as the "heat regenerating respirator," this Quartermaster-designed equipment demonstrated a high degree of efficiency in tests conducted under subzero temperatures in weather chambers at the Quartermaster Climatic Research Laboratory at Lawrence, Mass.

Metal wool absorbs the heat contained in the vapor expired by the breath and releases this heat to the inspired air. In this way, the upper respiratory tract and lungs of the wearer are protected against extremely cold air and body heat is conserved. At a temperature of 40 degrees Fahrenheit below zero, a person breathing a volume of 500 cubic centimeters and with a respiratory rate of 15 per minute may lose as much as 480 calories in 24 hours while at rest. Under moderate exercise the loss for the same person would be increased to 1,730 calories in 24 hours.

LARGEST DIE FORGING PRESS

Large light-metal press forgings, considerably larger than any previously obtainable, are made possible by the 18,000-ton die forging press now in operation by the Wyman-Gordon Products Corporation. Both magnesium alloys and aluminum alloys—including the high-strength aluminum alloy 75-S—are being successfully forged in parts up to 500 pounds in weight, with even larger pieces in prospect.

This press is the largest press and probably the largest single piece of machinery of any kind in America. It is more than twice as large as any other die forging press in this country.

ELECTRONIC CALCULATOR

A mechanical "memory" is one of the outstanding features of a new calculating machine called the EDVAC—electronic discrete variable computer—now being constructed at the University of Pennsylvania for the Ordnance Department.

The EDVAC is much faster, smaller, and less costly than the famed ENIAC—electronic numerical integrator and computer—which was also made at the university for Ordnance. The ENIAC is 1,000 times faster than any previous computer, but its many parts, including 18,000 vacuum tubes, crowd a fairly large room, while the EDVAC has only 3,000 electronic tubes and takes up only one-fifth as much space.

The War Department General Staff has directed that the Ordnance Department be responsible for the compilation and reporting of requirements on all Ordnance items peculiar to air operations.

NEW GASOLINE ENGINES

Military development of interchangeable gasoline-engine cylinders from which three families of engines in a wide range of horsepower may be made is the latest contribution of the Ordnance Department to industrial progress. The concept of the standardization of individual air-cooled cylinders is radical in that many different engines may be made essentially by the process of assembling a given number of the cylinders and supplying the proper crankshaft for each engine. Range of horsepower possible is from 15 to 1,400, and cylinder groupings may be "in-line," "V," or horizontally opposed. Thus, there is extreme flexibility in shape to fit radically different applications. Space and weight savings are of a high order, and with all the engines a wide temperature range of operation is allowable.

★ ★ ★ ★ ★ ★

43 YEARS OF
Spicer
SERVICE

UNIVERSAL JOINTS
★ ★ ★
PROPELLER SHAFTS
★ ★ ★
TRANSMISSIONS
★ ★ ★
POWER TAKE-OFFS
★ ★ ★
FRONT AND REAR
PASSENGER CAR AXLES
★ ★ ★
PARISH FRAMES
★ ★ ★
CLUTCHES

SPICER MANUFACTURING
Division of Dana Corporation
TOLEDO 1, OHIO

•

CALOMEL

MERCURIC OXIDE

BLUE PRINT CHEMICALS

IODINE

A FULL LINE OF MEDICINAL
AND TECHNICAL CHEMICALS

Manufacturing Chemists

PFIZER QUALITY
Est. 1849

CHAS. PFIZER & CO., INC.

81 MAIDEN LANE, NEW YORK, N. Y. 444 W. GRAND AVE., CHICAGO, ILL.

Tredegar Company

(Tredegar Iron Works Established in 1836)

✦

Makers of Supplies for United States Navy and Army; also Railroad and Boat Spikes, Angle Bars and Fish Plates, Car Wheels, and Horse and Mule Shoes.

✦

THE TREDEGAR COMPANY

RICHMOND -:- VIRGINIA

OVERLOAD PROTECTION
with
LIFETIME
CALIBRATION
in this
NEW
MANUAL
STARTER

Westinghouse "De-ion" Motor Watchman with "De-ion" arc quenchers

For Motors up to 7½ hp.

For positive protection against overload, specify the Westinghouse Motor Watchman. The Bi-Metal relay is calibrated at the factory to give lifetime accuracy. It never varies. Safety is further assured because starter cannot be held in "ON" position under continued overload.

For full information, ask for Folder F8474 and Price List 10-100.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

J-21045

Westinghouse

AMERICAN CHAIN & CABLE
BRIDGEPORT • CONNECTICUT

★
ACCO PRODUCTS
•
FOR INDUSTRY TRANSPORTATION AGRICULTURE
★

ACCO

In Business for Your Safety

- **CHAIN** .. Weed Tire Chains • Welded and Weldless Chain and Attachments — **AMERICAN CHAIN DIVISION**
- **CABLE** .. Tru-Lay Preformed Wire Rope and Crescent Non-Preformed Wire Rope — **AMERICAN CABLE DIVISION**
- **AUTOMOTIVE & AIRCRAFT** .. Cable, Controls, Fittings • Tru-Stop Brakes for Trucks and Buses — **AUTOMOTIVE AND AIRCRAFT DIVISION**
- **CUTTING MACHINES** .. Wet Abrasive Cutting Machines • Nibbling Machines — **ANDREW C. CAMPBELL DIVISION**
- **CHAIN BLOCKS** .. and Trolleys — **FORD CHAIN BLOCK DIVISION**
- **WIRE ROPE** .. Lay-Set Preformed Wire Rope • Nonparell Non-Preformed Wire Rope — **HAZARD WIRE ROPE DIVISION**
- **PRESSURE GAGES** ... **HELICOID GAGE DIVISION**
- **AUTOMOTIVE EQUIPMENT** .. for garages and service stations — **MANLEY MANUFACTURING DIVISION**
- **WIRE** .. Welding Wire, Shaped Wire, Manufacturer's Wire, Chain Link Fence — **PAGE STEEL AND WIRE DIVISION**
- **LAWN MOWERS** .. Lawn Cleaners — **PENNSYLVANIA LAWN MOWER DIVISION**
- **VALVES** .. Bronze, Iron & Cast Steel — **READING-PRATT & CADY DIVISION**
- **AUTOMATIC REGULATING VALVES** — **d'ESTE DIVISION**
- **CASTINGS** — Steel • **READING STEEL CASTING DIVISION** — Malleable Iron • **AMERICAN CHAIN DIVISION**
- **HOISTS AND CRANES** .. Wright Chain Hoists, Electric Hoists, Cranes — **WRIGHT MANUFACTURING DIVISION**
- **BOLTS AND NUTS** .. Lag Screws and Forgings — **THE MARYLAND BOLT AND NUT COMPANY**
- **SPRINGS** .. Owen Springs and Units for Mattresses and Furniture — **OWEN SILENT SPRING COMPANY, Inc.**
- **HARDNESS TESTERS** .. ("Rockwell") — **WILSON MECHANICAL INSTRUMENT CO., Inc.**

In Canada .. **DOMINION CHAIN COMPANY, *Limited***
In England .. **BRITISH WIRE PRODUCTS, *Limited***
THE PARSONS CHAIN COMPANY, *Limited*

GLOBE

BATTERIES
SPARK PLUGS
RADIO PARTS
STEATITE PARTS

GLOBE-UNION INC.
Milwaukee 1, Wisconsin
Factories: Atlanta, Boston, Cincinnati, Dallas, Los Angeles, Memphis, Milwaukee, Philadelphia

New Developments

Two cylinders are now available. One is "square" with a 5¾-inch bore and 5¾-inch stroke, while the other has a 4⅝-inch bore and 4-inch stroke. With the larger, combinations have already been worked out for a horizontally opposed, 6-cylinder engine, a V-8, and a V-12. For this group, the range is from 375 to more than 1,000 horsepower. From the smaller cylinder, 3 horizontally opposed engines of 4, 6, and 8 cylinders and a horsepower range of 100 to 300 have been worked out.

Universal interchangeability of all high-mortality parts such as cylinder liners, pistons and piston rings, and pins, valves, electrical accessories, and other parts within each family of engines is assured under this new cylinder-assembly plan.

IN THE NAVY

AUTOMATIC NAVAL ARTILLERY

New Navy 8-inch turret guns, developed since V-J Day as part of the Bureau of Ordnance program of adapting rapid, automatic features to large guns, will fire at battle ranges approximately four times faster than any gun of the same or larger caliber. The principle of automatic fire also has been applied to a 6-inch, dual-purpose gun and a new 3-inch, 50-caliber antiaircraft weapon. The rate of fire of the new 6-inch gun, the first rapid-fire antiaircraft mount of its caliber, has exceeded by a wide margin its original design specifications.

Automatic from ammunition-handling rooms to gun muzzles, the new 8-inch batteries eject cartridge cases from the mounts—powder bags having been abandoned in favor of cartridge cases to achieve the desired high rate of fire. The 8-inch and 6-inch mounts feature automatic fuze setting while the projectile is in the slide, insuring a small, uniform dead-time.

Three new cruisers now under construction, the U.S.S. DES MOINES, U.S.S. SALEM, and U.S.S. NEWPORT NEWS, will each carry nine of the rapid-firing 8-inch guns in three turrets.

Improvements similar to those for the 8-inch turret also have been applied to the 6-inch guns. These dual-purpose guns will be mounted in twin turrets, three forward and three aft, in a new light cruiser class of which the U.S.S. WORCESTER and U.S.S. ROANOKE are now under construction. The new light cruisers will not have the the usual 5-inch antiaircraft batteries but will depend upon smaller antiaircraft weapons for close-in defense.

The new automatic 3-inch 50-caliber gun mount has an automatic loader which doubles the rate of fire over the 3-inch gun used during World War II. It will throw a heavier, faster, VT-fuzed stream of fire into fast-flying aircraft and missiles and will replace the 40-mm. gun as the Navy's chief smaller antiaircraft weapon.

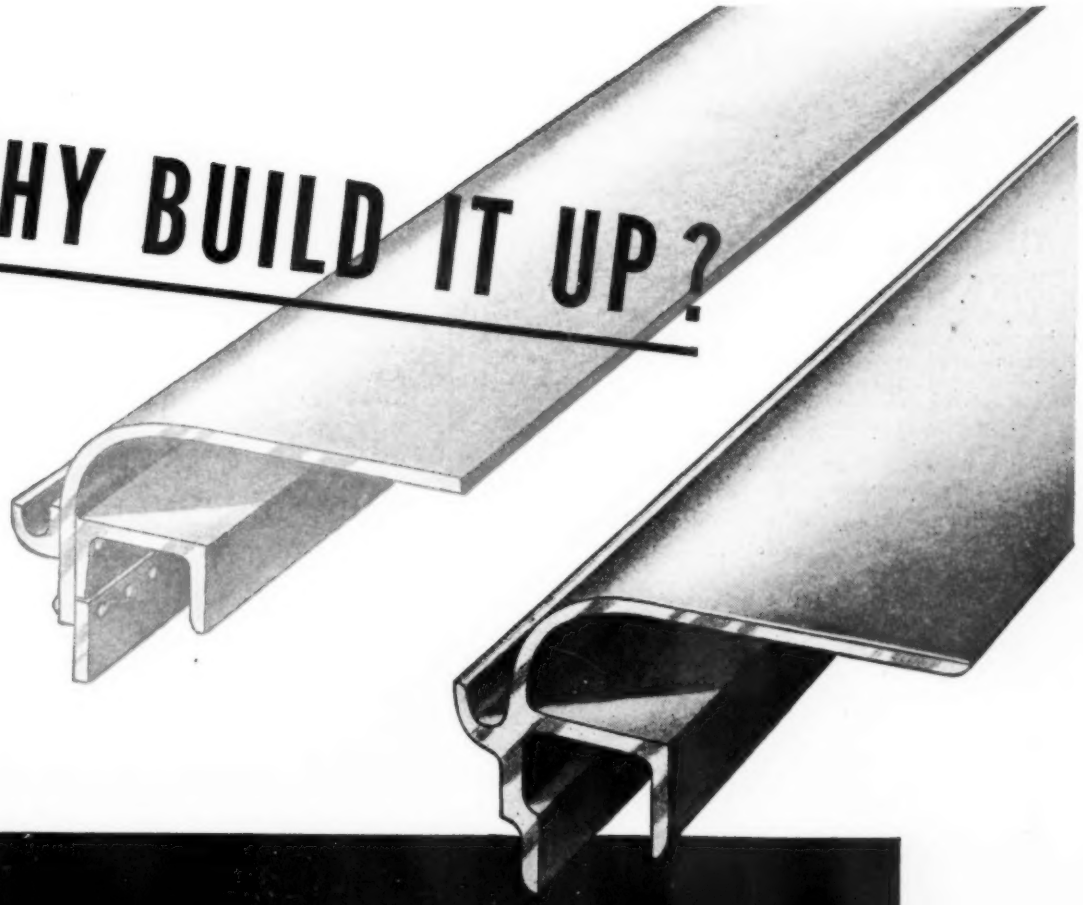
UNDERWATER PRESSURE TESTER

A contract for the construction of a 223-ton steel pressure vessel to be used in testing underwater equipment at the new Naval Ordnance Laboratory at White Oak, Md., has been awarded to the Babcock & Wilcox Company by the Charles H. Tompkins Company of Washington, D. C.

The vessel is a cylindrical drum, thirty feet long, with an inside diameter of one hundred inches and a shell thickness of nearly four inches. It will be made of steel with an ultimate tensile strength of 70,000 pounds per square inch and have a working pressure in the drum of 1,000 pounds per square inch.

Three windows of heavy pyrex glass will allow observation of the interior while testing is taking place. The drum is designed to simulate either underwater or atmospheric pressure, but will probably be used mostly for the former. It is expected that certain submarine apparatus and instruments which are exposed to water pressure, as well as other high-pressure underwater equipment, such as divers' suits, will be tested in this vessel.

WHY BUILD IT UP?



Buy an Extruded Shape, READY-TO-USE

You save material and labor when you order an aluminum extruded shape that fits your design. No need to build it up from angles, channels, tees, and other conventional shapes.

The aluminum in an extruded shape is used at maximum efficiency . . . strength where strength is needed, economy of metal where loads are light. No lap joints and double thicknesses to rivet through, no extra rivets to add weight.

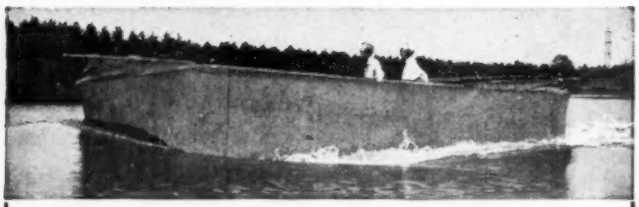
Die charges for extruded shapes of your own design are much less than you'd think.

Our engineers will be glad to help you adapt Alcoa Aluminum Extruded Shapes to the things you make. ALUMINUM COMPANY OF AMERICA, 2137 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in leading cities.

MORE people want MORE aluminum for MORE uses than ever.

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM



THIS IS A SHERMAN TANK . . .

transformed into an amphibious vehicle by Minneapolis-Moline Power Implement Company and others. It is powered by two propellers by which it is also steered. In the ocean it travels up to seven miles per hour. This transformed Sherman tank is credited with saving 10,000 lives on D-day alone. Minneapolis-Moline made many vital and important parts for this "transformation" and built many other vital and precision products that in some measure helped our armed forces in winning the war.

During the war, Minneapolis-Moline was the *first* and *only* company in the United States to win all the following awards:

1. Victory Fleet Flag and Maritime "M" Pennant. (Minneapolis plant) now with five Gold Stars each denoting six months of high production achievements.
2. Army-Navy "E" (Como plant) with an additional star for continued meritorious production.
3. The U. S. Army Ordnance Banner (Minneapolis and Hopkins plants). In addition, MM continued to produce vital products for farm and industry to help produce the food that always fights for freedom.

Minneapolis-Moline has now completely reconverted to peacetime products—which took little longer than it took Minneapolis-Moline to convert from peacetime production to produce products for Victory.

MINNEAPOLIS-MOLINE POWER IMPLEMENT COMPANY
Minneapolis 1, Minnesota, U. S. A.

Gilbarco

Quality is one ideal from which Gilbarco has never deviated in its 80 years of manufacturing. The use of only the finest materials and skills to build products of enduring excellence is a policy which has made the Gilbarco nameplate a symbol of dependability throughout the world.

Gasoline Pumps
Air Compressors
Air Meters
Automotive Lifts
High and Low Pressure Greasers
Kerosene Pumps and Outfits
Oil Storage Equipment
Barrel Pumps
Aviation Fueling Equipment
Oil Burners
Air Conditioning Equipment
Installation Necessities

GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASSACHUSETTS

New Developments

SMOKELESS PROPELLANT

The performance of a smokeless propellant in a jato (jet-assisted take-off) unit designed for Navy carrier-based aircraft is described in a report (PB 32219) on sale by the Office of Technical Services, Department of Commerce, Washington, D. C. Test models powered by the new solventless extruded powder exhibited high thrust and long-burning capacity without creating deposits of smoky film on carrier decks or the windshields of following planes.

Navy specifications for the experimental work called for development of a Jato unit to be propelled by a practically smokeless powder with an approximate burning time of 10 seconds and a thrust of 1,000 to 1,500 pounds per square inch in temperatures ranging from minus 15 to plus 120 Fahrenheit.

IN THE AIR

NEW CARGO PARACHUTE

A 75-mm. howitzer, weighing 2,240 pounds, was successfully lowered from a Fairchild C-82 Packet recently using a series of two ribbon parachutes. The new method of dropping heavy equipment from aircraft is a result of research by engineers of the Air Matériel Command at Wright Field, Ohio, as part of a program of coöperation between the Army Air Forces and the Army Ground Forces to make heavy field equipment as mobile as possible for the resupply of troops in the field through air transportation.

The first chute, a small 14-foot ribbon canopy, pulls the heavy cargo through the rear doors of the giant airplane. Once clear of the fuselage, a 90-foot ribbon chute opens to lower the howitzer safely to the ground.

THE BOEING STRATOFREIGHTER

The Army Air Forces YC-97 "Stratofreighter," built by the Boeing Aircraft Company, is a cargo version of the B-29. It spans 141 feet 2 inches across the wing and is 110 feet 3 inches long. It is capable of attaining a maximum speed in excess of 300 miles an hour and can carry its cargo load approximately 4,000 miles. It carries a crew of five and operates at a service ceiling of 30,000 feet.

MACHINE TOOLS STORED

Actual processing of machine tools for extended storage is expected to begin shortly in Airframe Assembly Plant Number One, Omaha, Nebr., according to officials of Air Matériel Command. As part of the air industrial preparedness planning program, approximately 15,000 AAF general-purpose machine tools and items of metalworking equipment will be stored in the Omaha plant. The contractor for this project is the Victory Machinery Movers, Inc., of Chicago, Ill., and it is anticipated that the storage of these tools will be completed in fifteen to sixteen months. Storage of additional thousands of machine tools will be similarly undertaken throughout 1947, but sites have not yet been determined.

AAF CLIMATIC HANGER

The Army Air Forces' Climatic Hangar is nearing completion at Eglin Field, Fla., home of the AAF's Proving Ground Command. The hangar, which can simulate extreme weather conditions, was developed by the AAF to meet the need for a central testing site where new aircraft and equipment might be subjected to climatic conditions which might be encountered in operational use.

Manufacturers of over 360 different products for home and industry

ARMSTRONG CORK COMPANY
Lancaster, Pennsylvania

MAKER
OF DIVERSIFIED
WIRE PRODUCTS

★

THE L. A. YOUNG SPRING & WIRE CORP.

9240 RUSSELL STREET

DETROIT MICHIGAN

LANSDOWNE STEEL & IRON COMPANY

MORTON, PA.

DESIGNING ENGINEERS

SPECIAL MACHINERY BUILDERS

HOLLOW FORGINGS - - TEXTILE MACHINERY

HYDRAULIC FORGING EQUIPMENT

NEW TL-20
WILL PICK IT UP AND PUT IT DOWN AT A SAVING

Put *skilled labor* in the form of a new TL-20 crane, on your material handling jobs and still save time and labor! This unit will travel speedily anywhere without benefit of rails, handle every type of work from hook block and magnet to clamshell and dragline.

The Lorain TL-20 is a dependable "one man gang" that is always on 24 hour call. Ask your local Thew-Lorain distributor for information on the TL-20—something *really new* in the ½-yd. class.

TL-20 FEATURES

Unit Assembly. Interchangeable Parts. Anti-Friction Bearings. 2-Speed Crawler. "Full Circle" Steering. 9 Rubber-Tire Mountings. All-Purpose Crane Boom.

The Thew Shovel Company
LORAIN, OHIO

HEIL
Quality
PRODUCTS

Bodies & Hoists
Transport Tanks
Road Machinery
Heating Equipment
Dehydrators
Bottle Washers
Water Systems

Serving the world with equipment for
1 Better Foods
2 Better Homes
3 Better Roads
4 Better Transportation

A-11

THE HEIL CO.
GENERAL OFFICES • MILWAUKEE 1, WISCONSIN

QUICK-READING
TEMPERATURE-CONVERSION TABLES

For speed, when you're converting degrees F to C, and vice versa, you can now use a simple, compact "Sauveur-type" table all the way from absolute zero to 1750 C and 3182 F, in increments of one degree.

For quantities, there's a slight charge: ten copies for 75¢; 50 for $3.25; 100 for $6.00. To minimize bookkeeping, we must ask that orders be accompanied by check for the exact amount, addressed to our Advertising Dept. . . . but please note that a single copy will be sent free on request. Better get one!

LEEDS & NORTHRUP COMPANY, 4901 STENTON AVE., PHILA. 44, PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES
Jrl Ad EN-33(1)

New Developments

In the hangar and test room, controllable temperatures between minus 70 degrees Fahrenheit and plus 165 degrees can be produced and maintained at any time. Provisions have also been made for simulated windstorms of velocities up to one hundred miles an hour in combination with sleet, snow, rain, and sand. In addition, artificial sunlight equivalent to noonday desert sun can be simulated.

Completely assembled aircraft can be tested within the hangar. In the rear wall of the hangar five gun ports have been constructed at different elevations to allow the testing of armament. In the floor of the hangar is a bomb-dropping pit which will permit dropping of dummy bombs for testing of bomb racks and release mechanisms. Other features of the hangar include a jungle test room, a tropic-marine test room, and a desert test room; a stratochamber which can produce pressures and temperatures corresponding to those encountered at an altitude of 80,000 feet; and a jet engine air unit, which can supply up to 103,000 cubic feet of air per minute for jet intake.

A NEW SHOOTING STAR

A new jet-propelled P-80 Lockheed Shooting Star fighter plane with greater firepower and more resistance to battle damage has recently been developed. The AAF has just purchased 134 more of these very high speed craft for $3,681,960, bringing to 1,066 the number of P-80's delivered or on order.

Known as the P-80-B, the new Shooting Stars are believed to have the greatest firepower of any jet fighter in the world. Structural improvements to the plane include thicker skin and stronger bulkheads in the nose section to provide a sturdier base for the Shooting Star's armament and the use of stainless steel around the engine for greater fireproofing against enemy attacks.

Pilot ejector seats will shoot the pilot clear of the plane in case of trouble, and air conditioning in the pressurized cockpit will maintain comfortable temperatures of between 70 and 80 degrees. Radio masts and antenna wires have been enclosed in the new P-80 for the first time on any airplane. Water injection in the Allison-built super turbo-jet engine increases take-off and climb performance materially.

A NEW FIREBALL

The new Ryan XF2R-1 jet fighter plane, unveiled recently as the Navy's first combat aircraft with a gas turbine driving a propeller, uses a 2-engine power plant combination composed of General Electric jet engines, the TG-100 Propjet and the I-16. The Propjet both drives the propeller and boosts with jet propulsion, while a separate I-16 jet engine, installed in the aft fuselage section, supplements the power of the propeller in giving peak performance for terrific bursts of speed and phenomenal climb.

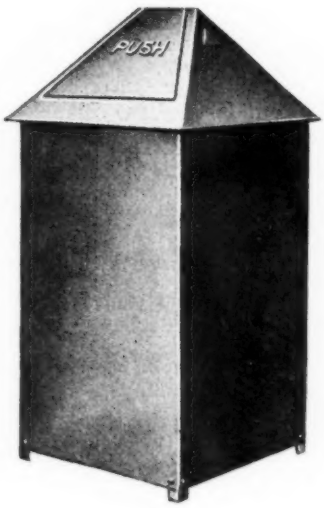
B-50'S ARE COMING

The remote-controlled armament and sighting systems and other aircraft instruments developed for the Boeing B-29 bombers will be used as standard equipment on the 133 advanced-type B-50 Boeing Superfortresses now being built for the AAF.

First of the B-50's, similar to the Boeing B-29 only in size and general appearance but providing outstanding advancements in load, range, and high-speed performance, will be completed shortly. The new bomber has 59 per cent more power than the B-29 by using four 3,500-horsepower engines, as compared with the 2,200 maximum horsepower for each of the B-29's power plants.

AUTOMATIC RADAR LANDING SYSTEM

An automatic radar landing system which, used with a standard ground controlled approach (GCA) unit, will elec-

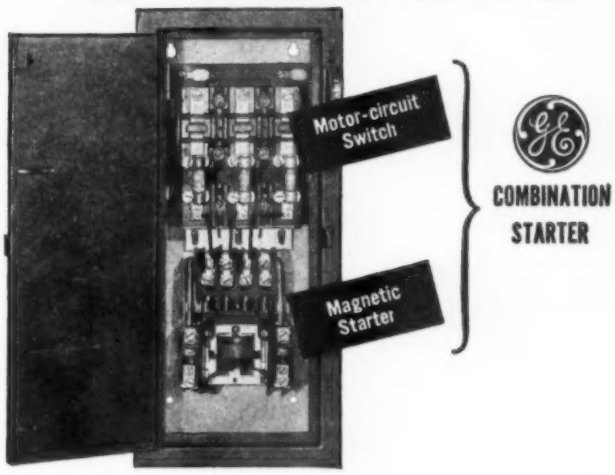


THE SOLAR
Self-Closing Receptacle

—will protect all parts of your building. It is the modern all-steel method of handling waste efficiently.

Solar-Sturges Mfg. Co.
Melrose Park, Ill.

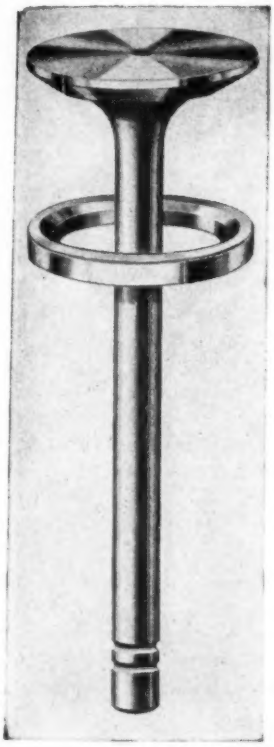
WHY TWO DEVICES?
ONE CAN DO THE JOB



Gone are the days when you had to buy a separate device for each function of motor control. Now, whatever your plant's operating conditions, you can get *combination* control.

We have combination starters for general-purpose duty and for hazardous locations, and also corrosion-resistant, dust-tight, and watertight forms. *General Electric Co., Schenectady, N. Y.*

GENERAL ELECTRIC



Not
"just any Seat Ring"
for "just any Valve"
Make 'em fit!

When you've selected the right valve—and of course it's a Rich Valve—get exactly the correct Valve-Seat-Ring to fit the Valve . . . and to fit the job! Wilcox-Rich Engineers know the right combinations to give you best results. Ask their advice!

America's No. 1 Authority on Valve Mechanisms

WILCOX-RICH, *division of* **EATON MFG. CO.**, Detroit

HENRY & WRIGHT DIEING MACHINES

Capacities from 10 tons to 300 tons

50-TON MACHINE ILLUSTRATED AT LEFT

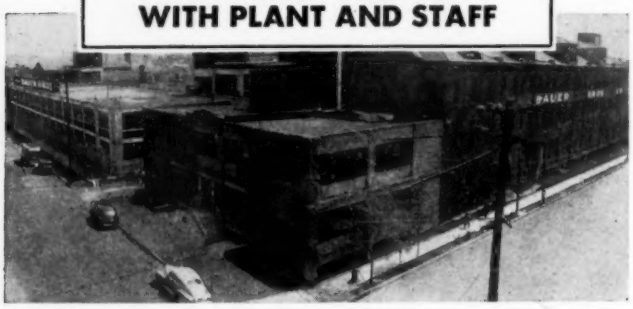
Producing intricate stampings
COMPLETE-PER-STROKE

During the war, Dieing Machines produced all manner of munitions, airplane, and instrument stampings COMPLETE PER STROKE on progressive dies at an unequaled combination of high production and high precision—maintaining precision of product within .0002" limits when required. Today these famous machines are again available for producing industrial and consumer stampings at new low cost. Competent engineering counsel.

Request—
"CATALOG 47"

HENRY & WRIGHT MFG. CO.
770 Windsor St., Hartford 1, Connecticut

AT YOUR SERVICE
WITH PLANT AND STAFF



● Bauer specializes on the design and manufacture of grinding and separating equipment; also offers laboratory service on commercial size machines for grinding and separating experimentation.

THE CURRENT BAUER LINE

Machinery for crushing, breaking, grinding or granulating many industrial materials—wet or dry.
Fluffing equipment for sheet pulp nitrating purposes and pulp stock preparatory units.
Oil Mill Machinery, including units for cleaning, decorticating, separating and grinding of Oleiferous seeds, beans, nuts, etc.
Peanut processing equipment for shelling plants, peanut butter plants, salted nut plants, confectioners, bakers, etc.

Bauer

If it is a grinding or separating problem, Bauer may already have the equipment needed—or be able to build it special.

THE BAUER BROS. CO., SPRINGFIELD, OHIO

Explosives and blasting supplies for blasting work on airports, highways, harbor channels and demolition operations.

CHEMICALS ATLAS EXPLOSIVES

ATLAS
POWDER COMPANY
Wilmington 99, Delaware

Industrial Explosives — Coated Fabrics
Blasting Supplies — Activated Carbons
Product Finishes — Chemicals

tronically and without human aid bring an aircraft to within a few feet above a runway has been developed by the Army Air Forces. The new device, which can be used with either the automatic pilot or with the present instrument landing system (ILS), will be able to land all the following types of aircraft:

(1) Aircraft not equipped with landing aids will land by the regular "talk-down" method, with the control tower operators utilizing the normal monitoring scopes in or adjacent to the control tower room. (2) Aircraft equipped with visual instrumentation, such as cross-pointed meters (as used with ILS), will be furnished information for manual landings by the pilot unassisted by ground controllers. (3) Aircraft equipped with automatic pilots electrically connected to the radio landing equipment will be landed automatically unassisted by ground controllers.

THE NAVY'S "SKYSTREAK"

The D-558 Skystreak, a new Navy jet-propelled plane, designed to fly at speeds approaching the sonic barrier has recently been built by Douglas Aircraft Company. It will be shipped to the Army Air Base at Muroc Dry Lake, Calif., in the near future where it will commence its flight test program.

The General Electric TG-180 turbo-jet, the largest jet engine built in America, will power the Skystreak on its 600-700 mile-an-hour flights. At maximum speed the turbo-jet will produce horsepower equivalent to the four engines of a B-29, or the combined power of seventy-five average automobiles. To supply answers to engineering questions, the Skystreak will carry 500 pounds of test and recording equipment aloft on its flights.

YB-49 JET BOMBER

The Army Air Forces' newest jet bomber, the YB-49, was built at the Northrop plant at Hawthorne, Calif. The YB-49, a jet-propelled version of the B-35 "Flying Wing," spans 172 feet across the wing, but is only 53 feet long, due to the absence of the conventional fuselage. It is powered by 8 General Electric J-35 jet engines, capable of producing a total of 32,000 pounds' thrust, arranged in groups of 4 on either wing. The plane has a service ceiling in excess of 30,000 feet.

PHOTO-RECONNAISSANCE AIRPLANE

The Army Air Forces' photo-reconnaissance plane, the XF-11, built by Hughes Aircraft Company of Culver City, Calif., has been designed for high-speed photographic work. It is a twin-boomed, 2-place monoplane, spanning 101 feet 5 inches across the wing and 65 feet 5 inches long. Powered by two Pratt & Whitney 3,000-horsepower engines driving two 8-bladed counterrotating Hamilton Standard propellers, the plane is capable of speeds in excess of 400 miles an hour. Built for long-range work, the XF-11 has a ceiling of over 40,000 feet. A pressurized cabin makes oxygen masks unnecessary.

XB-45—NEW ARMY BOMBER

One of the first of the Army Air Forces' four jet engine propelled bombers, the North American XB-45, successfully completed its first test flight recently. A significant development in military aviation, the XB-45 is one of America's first operational bombers to employ jet propulsion. The plane has a wing span of 89½ feet, is 74 feet long, and 25 feet high from the ground to tail top.

Its four jet engines, General Electric designed J-35's, manufactured by the Allison Division of General Motors, are arranged in pairs in single nacelles on each wing. The engines are located entirely ahead of the leading edge of the wing for ease of accessibility and maintenance. Designed for high speeds, the XB-45 has the sleek lines of a modern fighter and is entirely free of protruding gun turrets.

Sturtevant

REG. U. S. PAT. OFF.

Puts Air to Work

EQUIPMENT FOR:

Ventilating—Heating—Air Conditioning—Drying—Dust and Fume Removal—Mechanical Draft—Vacuum Cleaning—Pneumatic Conveying—and other air handling purposes.

☆

B. F. STURTEVANT COMPANY
Hyde Park Boston, Mass.

Branches in 40 Principal Cities

84 YEARS OF AIR ENGINEERING EXPERIENCE

where **EVERY MINUTE COUNTS...**

...you can rely on CLEVELAND DRILLS and REAMERS

The CLEVELAND TWIST DRILL COMPANY
1242 EAST 49TH STREET
CLEVELAND 14

TRADE MARK REG. U. S. PAT. OFF. AND FOREIGN COUNTRIES

20 THOMAS ST., NEW YORK 7 • 9 NORTH JEFFERSON ST., CHICAGO 6 • 250 HOWARD ST., SAN FRANCISCO 5
259 EAST GRAND BLVD., DETROIT 2 • 1962 NORTH HELTON ST., DALLAS 1
E. P. BARRUS, LTD., LONDON, W. 1, ENGLAND

Better grinding fluid means Better Grinding

Stuart's

CODOL

LIQUID GRINDING COMPOUND

...The best grinding fluid you can use!

FOR FURTHER INFORMATION WRITE

D.A. Stuart Oil CO. LIMITED
EST. 1862

2729-29 SOUTH TROY STREET, CHICAGO 23, ILL.

Stuart Oil Engineering Goes With Every Barrel

VICTOR

Gaskets of all kinds—
Oil Seals—Molded
Synthetic Rubber Products
Shims—Washers—Stampings—Asbestos Millboard

VICTOR MFG. & GASKET CO.
P. O. Box 1333 Chicago, U. S. A.

DEAD BIRD!

For skeet, waterfowl or upland game Savage automatic shotguns have the built-in balance, fine handling qualities, and unfailing dependability that give the shooter every advantage. See these great guns at your dealer's.

Savage Arms Corporation
Utica, N. Y.
Operating plants in Utica, N. Y. and Chicopee Falls, Mass.

SAVAGE

Savage Automatic Shotguns, in both standard and lightweight models, are now in production.

CASTINGS

Open Hearth Steel
Electric Steel
Alloy Steel
and
Malleable Iron

Railroad Car Equipment

Automatic Couplers
Draft Gears
Journal Boxes
Trucks
Wheels

NATIONAL MALLEABLE AND STEEL CASTINGS CO.
General Office—Cleveland, O.

Guided Missiles

PARACHUTE DESCENDS 68 MILES

The highest parachute "jump" in history took place at White Sands Proving Ground, N. Mex., when Army experts installed one of the new "ribbon" canopies in the nose of a V-2 rocket that soared to a height of sixty-eight miles. The purpose of the test was to lower gently from the ionosphere delicate scientific instruments in the nose of the rocket.

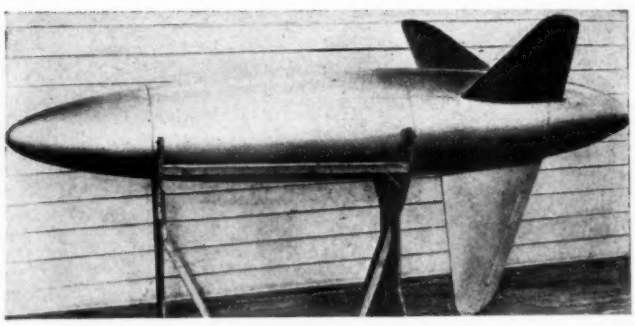
The parachute, previously tested on smaller rockets from altitudes under thirty miles, was ejected at the zenith of the rocket's flight and functioned successfully.

The rocket contained cameras for taking color photos and instruments for measurement of cosmic rays, pressures and temperatures, and the voltage arc-over of electrical equipment in the upper air.

The test was a joint operation of Army Ordnance and the Air Matériel Command, with University of Michigan scientists collaborating on the pressure-temperature phase.

THE "TIAMAT"—NEW GUIDED MISSILE

Development of a subsonic model for future guided missiles equipped with explosives and target seekers has been disclosed by the National Advisory Committee for Aëronautics. Called the "Tiamat," the experimental pilotless aircraft was described as



The Tiamat target-seeking rocket.

"the first guided missile to be flown successfully through a predetermined program of maneuvers."

A winged rocket, the Tiamat's design can be adapted to supersonic missiles powered by jet engines. The missile is roughly comparable to the German V-1 in that it has wings to sustain it in flight. But it is much faster, is rocket-propelled, and can be guided accurately to a predetermined target.

INSECTS SURVIVE V-2 FLIGHT

Living organisms have survived the penetration of the ionosphere in the war head of a captured German V-2 rocket fired from White Sands. Fruit flies, included in containers which held instruments and cameras in the rocket, were recovered alive and seemingly none the worse for their experience. The containers were lowered successfully by ribbon parachutes.

The effect on the insects of the flight at supersonic speeds along with the exposure to the terrific heat and cosmic radiations of upper-air regions were part of experiments conducted by AAF technicians and civilian scientists coöperating with the Ordnance Department. The latter agency has the responsibility for the firing of all the V-2 rockets at White Sands.

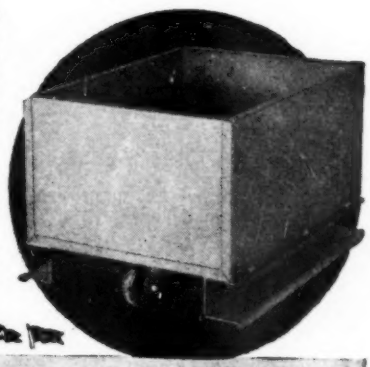
Announcing

a newcomer to a growing line of fine materials handling equipment

the **TOTE BOX**

ORIGINALLY designed for one of America's largest aircraft producers to move and store small screw machine parts. Can be used for short spottings by hand, or for long hauls and tiering with fork lift truck.

Size—18″ x 24″ x 12″. Body of truck—16 ga. steel. All spot-welded. Provided with tiering channels, two 4″ stationary casters, and one 4″ swivel caster. Capacity—500 lbs.



The UNION METAL Manufacturing Company

CANTON 5, OHIO

THE NARROW FABRIC COMPANY

Reading, Pa.

★

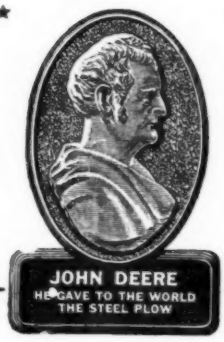
Manufacturers of

BRAIDED PRODUCTS FOR ORDNANCE

★

Specialists in Cordage for Shroud Lines and Braided Reënforcements used in the Manufacture of Parachutes

★ ★



QUALITY

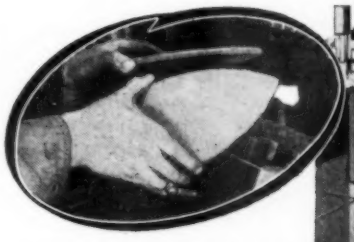
FARM EQUIPMENT

FOR OVER A CENTURY

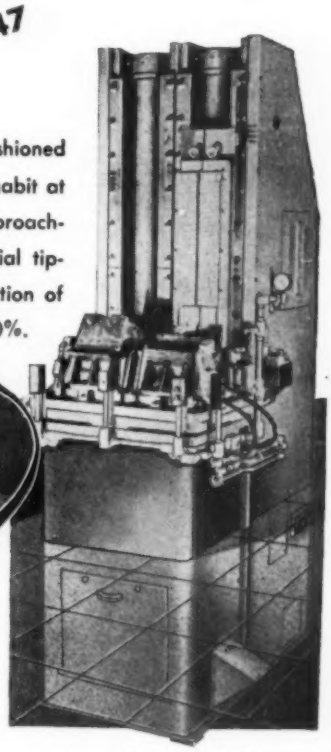
JOHN DEERE
MOLINE, ILL.

POSTWAR SUCCESS STORY . . . 1947

Ironing out old-fashioned production wrinkles is a habit at Lapointe! This 15 ton DRV broaching machine with a special tip-up fixture jumped production of flat iron bases a full 300%.



Close up of bases—production 220 complete base plates per hour.



15 ton 66″ stroke double ram vertical machine.

THE *Lapointe* MACHINE TOOL COMPANY
HUDSON, MASSACHUSETTS • U.S.A.
THE WORLD'S OLDEST AND LARGEST MANUFACTURERS OF BROACHES AND BROACHING MACHINES

A Convenient Source
for 25000 LABORATORY ITEMS

TECHNICAL, REAGENT AND C. P. CHEMICALS
•
APPARATUS
•
GLASSWARE
•
FURNITURE

Whenever you order chemicals or laboratory equipment, make Harshaw Scientific your regular source of supply. It is a satisfying habit . . . and a helpful one . . . for many P. A.'s.

You have 25,000 items from which to choose. Prompt attention is given to every order—large or small. Speed of delivery, as you know, depends upon existing conditions.

Write for a copy of our price list. You will find it convenient and extremely helpful in selecting and pricing the Technical, Reagent or C. P. chemicals you need.

HARSHAW SCIENTIFIC
CLEVELAND 6, OHIO 1945 East 97th Street
CINCINNATI 2, OHIO 224 Main Street
DETROIT 27, MICH. 9240 Hubbell Avenue

•

MOSSBERG

Rifles
Shotguns
Telescope Sights
Targo Guns and Equipment

Descriptive literature on request

O. F. Mossberg & SONS, INC.
NEW HAVEN 5, CONN.

69805 St. John St., New Haven 5, Conn.

•

Guided Missiles

GUIDED MISSILES PLANNING GROUP

Planning for the Nation's research and development programs on guided missiles is being done by a Joint Research and Development Board committee under the chairmanship of Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

Each of the four Army and Navy groups which have been most concerned with the guided-missiles program is represented on the committee by high-ranking officers. They are: Vice Adm. A. W. Radford, Deputy Chief of Naval Operations for Air; Vice Adm. G. F. Hussey, Jr., Chief of the Navy's Bureau of Ordnance; Brig. Gen. A. R. Crawford of the Army Air Forces; and Brig. Gen. H. B. Sayler of Army Ordnance. In addition to Dr. Compton, civilian members of the guided-missiles board include Dr. H. L. Dryden of the National Bureau of Standards, and Dr. E. R. Gilliland of M.I.T.

ROCKET FLIGHT SIMULATOR

To permit ground testing of guided-missile controls, a flight simulator or dummy rocket for duplicating flight characteristics of a rocket missile is under development as part of General Electric Company's long-range rocket research program.

The simulator will couple an intricate calculating machine with a mechanical arrangement of gymbals driven by servomechanisms. When completed, the guiding equipment to be used in any new type of rocket can be attached and tested in the same maneuvers through which the rocket will be directed when actually launched.

Research on controls for the simulator is being conducted by the Dunham Laboratory of Electrical Engineering at Yale University.

NEW TELEMETERING CONTROL SYSTEM

A new 15-pound telemetering system designed to track rockets speeding at approximately 3,800 miles an hour has been successfully tested in the V-2 missile firing at the White Sands Proving Ground.

Automatically transmitting twenty-eight items of information every thirty-fifth of a second, measurements of acceleration, position of control vanes, and fuel pressure as well as scientific data on rocket-skin temperature and other facts were received at the ground station and permanently recorded on film.

Enclosed in the rocket war head, the new missile-borne unit is packaged in two pressurized cans, each four inches in diameter and twelve and fifteen inches long, respectively. Power is supplied by a separate 28-volt battery located in the control compartment.

Since the system is mechanically commutated, each of a number of quantities of interest must be converted to a voltage that varies between zero and plus-five volts and must be connected to one segment of a stationary commutator. Twenty-eight such channels are provided, and a rotating brush samples each of these thirty-five times a second. These samples of voltage are converted to pulse-width-modulation; *i.e.*, a zero voltage input to one channel is converted to a 50-microsecond pulse while a 5-volt input is converted to a 650-microsecond pulse. A 5-watt transmitter sends this signal to the ground.

At the receiving station a linear sweep on one cathode-ray oscilloscope is triggered by the leading edge of each received pulse. The incoming signal is put on the intensity grid so a line, whose length is proportional to the quantity being measured, will appear on the scope. The film records while moving steadily in a vertical direction. All samples on all channels will appear as parallel lines of varying length. Thus one rotation of the commutator, or one sample of each channel, is represented by a block of twenty-eight parallel lines.

Founded 1920

ARMY ORDNANCE

Combined with FIREPOWER, the Ordnanceman's Journal

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

FEATURES

Jet Propulsion . . . . . Frontispiece
Strategic Air Power 493
Homing Missiles 494
Industrial Quality Control 496
COL. LESLIE E. SIMON
Preparedness for Air Power 497
BRIG. GEN. JOHN C. GORDON
Guided Missile Defense 500
PAUL W. MARTIN
High-Angle Bombs 503
L. O. GRONDAHL
Jet and Rocket Fighter Planes (Pictorial) 506
Task Force Frost 507
CAPT. A. M. KAMP, JR.
America's Air Power (Pictorial) 509
Smashing the Atom 513
HAROLD M. SHAW
High-Speed Ordnance Transporters 516
E. R. STERNBERG
Industry-Ordnance Leaders 518
"Little David" 520
COL. CLYDE H. MORGAN
Small Arms for Security 522
C. K. DAVIS
Printed Circuits 524
CLEDO BRUNETTI and PHILIP J. FRANKLIN
New Naval Air Speedsters (Pictorial) 526
Month by Month 527
National Security—1947 (An Editorial) 529

DEPARTMENTS

Communications . . . 468
New Developments . . 476
Guided Missiles . . . 488
Association Affairs . . 530
Professional Digest . . 534
Atomic Energy 535
Ordnance Glossary . . 536
Book Reviews 538
Index of Advertisements . 543

Vol. XXXI MAY-JUNE, 1947 No. 162

Copyright 1947 by the Army Ordnance Association, publisher, 705 Mills Building, Washington 6, D. C. Issued bimonthly. Single copy, 75c (by mail). Subscription rate: continental U.S. and possessions, $4.50 annually, in advance; foreign, $6.00. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Six weeks' notice before next publication date is required to effect change of address.

This issue of ARMY ORDNANCE marks the completion of twenty-seven years of continuous publication. The first issue was dated July-August 1920, less than a year after the Army Ordnance Association was founded in October 1919. During the period 162 issues—including this one—have been published. They comprise thirty-one complete volumes. The list of authors during this time is distinguished and lengthy. The subjects treated include all phases of ordnance science, industry, logistics, and progress. They do not present a harnessed point of view. Freedom of expression is as essential to military-industrial advancement as it is to academic progress.

Not once during the past twenty-seven years has ARMY ORDNANCE run away from an issue that threatened our military security. In these pages we have championed the Ordnance cause even if in doing so we went counter to the bureaucrats or the brass hats. On one occasion—the nefarious Nye Munitions Investigation in 1934—ARMY ORDNANCE was the only magazine the Nation over that fought the pacifists to a standstill. Had there been a few more sturdy helpers maybe the damage done at that time by political skulduggery could have been minimized. Certainly there would be fewer American graves in Europe, Africa, and the Pacific Islands today.

Whatever the Atomic Age holds for the security and peace of our country, let us hope that this journal, having won its spurs, will be able upon the completion of its forty-seventh year to look forward with the same confidence and hope as it does today. And may it have as many true friends!

—*The Editors*

Jet Propulsion

Strategic Air Power

It Can Stop a Strong Aggressor Before He Begins

The genial Gen. Carl "Tooey" Spaatz, Commanding General of the Army Air Forces, typifies the point of view of the airman. His philosophy on air power he expresses in few words:

He points to the German experiments in the Spanish Civil War which convinced the *Luftwaffe* that bombing of sensitive transportation units could paralyze the enemy.

World War II might have ended differently, he claims, if strategic bombardment by an air force capable of sustained independent action had been understood by the Nazis. Their mistake was to gear the German Air Force to the flywheel of the *Wehrmacht*, thereby producing no more than the third dimension of a blitz campaign.

The *Luftwaffe* marshal, Hermann Goering, had ample warning that he could not conquer Britain from the sky with the plan he was following, but the Nazis continued a misguided battle which fumbled their greatest opportunity for a quick end to the European war.

Strategic bombardment is the most powerful weapon of war because it embodies three of the principles of battle to a uniquely high degree: the principle of mass in attack, the principle of a fundamental objective in planning, and the principle of economy of force.

Air power demonstrated its decisive worth most conclusively in the triumph over Japan, says General Spaatz, when that country surrendered unconditionally while its armies remained undefeated in major engagements and 3,000,000 square miles of land remained under its control.

His picture on the front cover of this issue is the work of our staff artist LeBaron Coakley.—THE EDITORS.

THE people of the United States are already two years late in coming to their senses about the function of strategic air power in atomic warfare. Two years is an eternity in an age when split seconds can make or break our civilization if attacked by a major aggressor.

Should there be any doubt about the facts of modern war, some figures released by the Army may help to keep our thinking straight.

Our war with Mexico required 104,284 troops; it cost 12,946 in lives, 139,500,208 in dollars. In our war with Spain we mobilized 408,391 troops; it cost 6,472 lives and $992,159,840. World War I required 3,665,000 troops; there were 193,663 dead; it cost $21,000,000,000. In World War II we raised 10,200,000 troops; there were 313,000 dead; it cost $340,000,000,000.

For any one to hazard a guess about the cost of another world war would be futile. Whatever his guess, neither our country nor all the United Nations would survive it. Even the notion of another world war for us or for any other nation is tragic.

As it looks to us there are just two ways of keeping another major war away from ourselves. One way is of the heart; the other is of the head. Until the first way is firmly established among all the nations and over a long period of years, the second way is our only immediate salvation.

The way of the heart is by coöperation and mutual understanding, based upon religious ideals founded on a common moral basis. Such a way the United Nations may some day adopt. But it has given slight indication thus far that it has serious, realistic, peaceful intentions. U.N. up until now has failed to prove that it is more than a debating society. Until Christian principles rule men's hearts we need not expect enduring peace among nations.

Things being as they are there is but one road to peace now. It is by realistic preparedness—land, sea, and air. In none of these respects are we secure two years after V-E Day.

One of the most convincing and most startling studies of World War II was the strategic bombing survey prepared with painstaking care under the direction of Franklin D'Olier.

Since then the case for strategic air power has been clear. It is the *instantaneous* element of modern warfare. It supplants neither the function of a Navy nor the rôle of a ground Army. It simply multiplies the range and the firepower of both and reduces the time factor of the initial attack from days to hours.

Firm in this belief, the American people should leave no barrier in the way of a powerful strategic air force—free enough to cover great areas of the earth and strong enough to deliver a knockout blow at the military targets of an aggressor. Such a force should be freed of the shackles that have bound it to ground organizations.

Gen. Carl Spaatz, Commanding General of the Army Air Forces, made a strong case for strategic air power recently when he said:

"The strategy of defense, thus made compulsory by global geography, must emphasize the quality of our air preparations. We must have the right equipment for whatever task is to be performed at the zero moment, if it comes. The timing will be by moments, not by months and years as formerly. No longer can we envisage war as something happening first to other peoples, in other lands, overseas . . .

"Our new frontier is up. The era ahead is the airfaring age. A new capacity in speed and reach has come to us, which alters our concepts of space and time."

BUT along with its sister services, today our air power has been weakened below the safety point. All three should be streamlined, strengthened, and kept freely alert. Adequate strategic air power will give our fighting forces the range and the tonnage without which we will be unable to knock out enemy power *at the source*.

Anything less will not do if we intend to stay secure in the atomic age until men of all nations can live in brotherhood. To paraphrase a time-honored epigram—we will not have international peace until the strongest army, the strongest navy, and the strongest air force are in the hands of the most peaceful nation.

Homing Missiles

The Design and Development of Navy Bombs That Can Find and Hit Targets By Self-Contained Radar Control

They were designed to glide silently at the speed of a fighter plane carrying a 2,000-pound war head right to the target

THE "Bat," first fully automatic guided missile successfully used in combat by any nation, offers evidence that guided missiles have passed from the experimental stage to practical application as combat weapons. One of several guided missiles developed by the National Bureau of Standards under the sponsorship of the Navy Bureau of Ordnance, the Bat has led to further research on other advanced forms known as the "Kingfisher" series.

Work on guided missiles constituted one of the major war activities of the National Bureau of Standards. During the course of the work, such missiles as the "Robin," the "Pelican," and the "Bat" were completely developed. Because of the much greater operational flexibility of the Bat, however, it was the only one of these missiles carried into large-scale production and combat use.

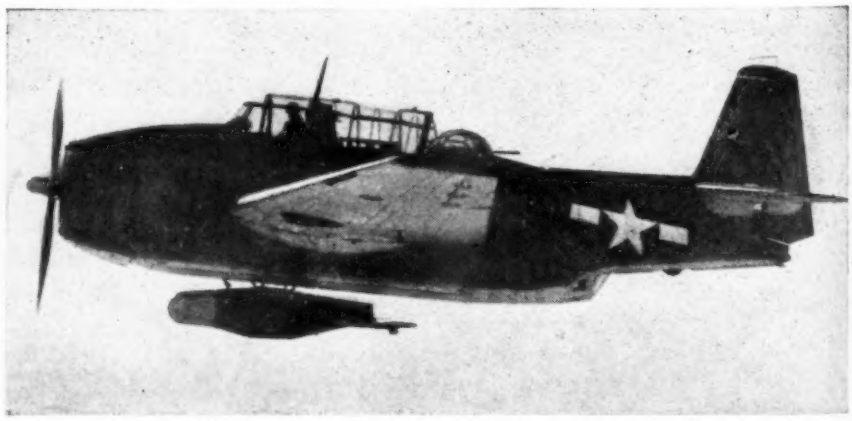
The program on guided missiles began in the fall of 1940 when the National Defense Research Committee requested the Bureau to permit the appointment of Dr. Hugh L. Dryden as aërodynamics consultant in connection with a contract for development of a glide bomb capable of being directed to the target by radio remote control utilizing television sighting.

IN April 1942 the Bureau acquired the use of an area for flight tests near Warren Grove, N. J., where tests were made with aircraft supplied by the Navy. From this period on, the several projects designated Robin, Pelican, and Bat were prosecuted simultaneously. Each of these projects utilized gliders of three different sizes designed to be carried externally by the dropping airplane. The unique type of aërodynamic control, suitable for homing missiles, was developed in the Bureau's Aërodynamics Laboratory.

Project Robin contemplated a missile incorporating a television transmitter with a pickup tube in the nose of the bomb and manual remote radio control by an operator with a television receiver in front of him. The full-scale missile was to carry a standard M34 2,000-pound bomb as pay load.

Twenty-six model gliders and fourteen full-scale gliders were flight-tested in connection with this project. Twenty-four of the flights were with television equipment. Gyro-stabilization was introduced in the seventh test. The tests were concluded in July 1943 when radar "homing" appeared to be a more practical solution of the guided-missile problem.

The Pelican was a radar device, but the missile contained only a receiver, the transmitter being on the "mother" airplane. A pulsed radar system was used, the transmitter emitting short



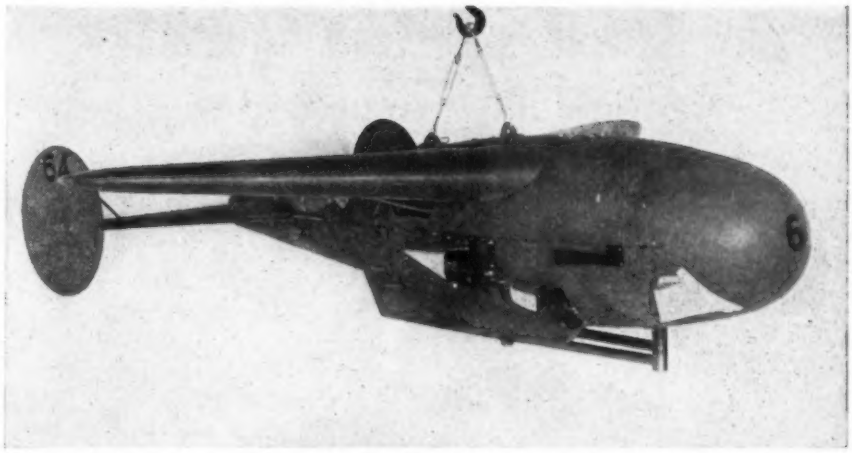
The Bat is shown mounted under a Navy torpedo bomber. Note the folded tail fins which will open into flight position after the bomb has been released, as shown in top photo.

pulses of high intensity. Directional information obtained from the returning echoes activated mechanisms within the missile which kept it headed for the target. The first flight test of a missile carrying an experimental radar receiver was made at the Warren Grove test area on November 12, 1942, followed a month later by the first flight showing homing control, the transmitter in both cases being located on the ground.

In order to handle the growing program of missile development adequately and also to assist the Navy in the assembly of missiles for evaluation and training purposes, the Bureau interrupted its work in hydraulics and devoted the entire hydraulic laboratory building and its staff to the guided-missile program.

A SPECIAL-PROJECTS section was established which grew to more than one hundred persons engaged in engineering development, production engineering, assembly, inspection and testing, and field tests. The Navy established an ordnance experimental unit at the National Bureau of Standards, operating under the technical leadership of the Bureau and the Radiation Laboratory.

Various difficulties, both aërodynamic and radar, as well as the development of an improved target-selector circuit, delayed final selection of a production design. The first production glider was tested against an elevated beacon on June 10, 1943. Attention was then turned to tests against a water target and to illuminating techniques with the transmitter in an airplane, all previous tests having been made with transmitter on the ground. Tests of this nature were made against a barge in the Chesapeake Bay in October 1943. In 1944, however, the Pelican was returned to an experimental status, largely because the Bat appeared to be nearly ready for use.



The Pelican was developed concurrently with the Bat, being controlled by radar impulses sent out by a mother plane which echo from the target to the bomb.

Designed to glide silently at the speed of a fighter plane with a 1,000-pound bomb as cargo, the Bat is carried under the wing or fuselage of a Navy fighter or bomber and may be released at a distance as great as fourteen miles from the target. Once the crew of the mother plane has located a target, the missile is set for this particular object and the release button is pushed. From then on the Bat automatically follows every maneuver of the target until it eventually strikes home, while the mother plane is free to proceed as its pilot wishes.

The code name "Bat" suggests the principle upon which this guided missile operates. A live bat gives out short pulses of sound and is guided by the echo, thus avoiding collision in the dark. The Bat missile emits pulsed microwave electromagnetic radiation and is directed by the radar echoes.

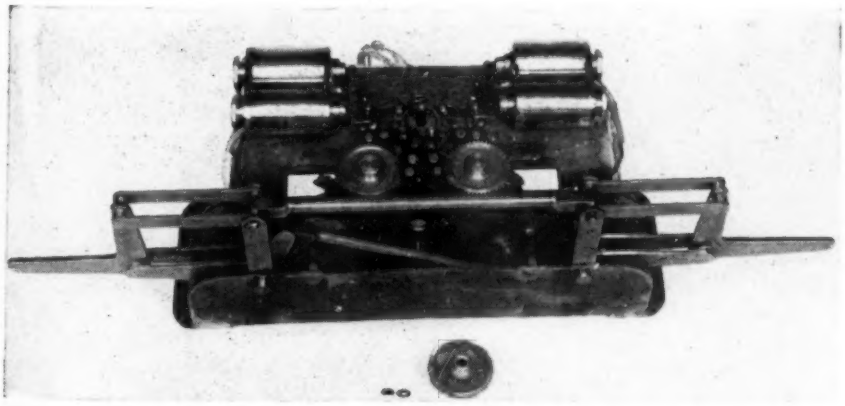
In normal usage the target is first located by the standard search radar of the mother plane. The plane is then headed toward the target, and the radar transmitter and receiver in the Bat are aimed in its direction. Target data from the radar in the missile is displayed on a separate indicator in the mother plane under the control of the operator.

After the radar equipment is manually adjusted to the proper conditions, it is switched to automatic tracking, and the missile is released. Echoes from the target are continuously detected by the radar receiver in the missile, and the output supplies correction signals to the flight-control units to direct the missile toward the target.

THE outstanding features of the Bat as a combat weapon are (1) long range, which provides the ability to attack heavily armed targets with accuracy from outside the antiaircraft zone; (2) improved accuracy, a result of the self-homing feature; (3) low angle of flight, which reduces high-altitude problems; (4) high pay load; and (5) self-guidance after release, permitting the carrying plane to maneuver as desired.

The Bat is equipped with a gyroscopic stabilizing unit and a servo system to move the control surfaces of the air stabilizer. This equipment, together with the bomb load, is mounted in a glider-type airframe about twelve feet long with a 10-foot wing span.

Development of this complex weapon resulted from close coöperation among a number of organizations. Dr. Hugh L. Dryden, of the National Bureau of Standards, coördinated the technical work of the civilian agencies while Capt. Dundas P. Tucker, of the Bureau of Ordnance, integrated the activities of the military groups. According to the Navy, the Bat was very effective against Japanese combatant and merchant shipping during the last year of the war.



This is an early model of the servo unit used in the Bat to move control surfaces.

Industrial Quality Control

An Ordnance Contribution to Efficient Mass Production

Col. Leslie E. Simon

AMERICAN industry probably regards statistical methods for quality control as one of the war's benefits. However, few things come to fruition during the heat of war unless they have been carefully cultivated in time of peace. As early as 1933, Ordnance recognized the usefulness of statistical techniques for writing good specifications, for obtaining more uniform production at lower cost, and for acceptance inspection.

When World War II began, Ordnance had ten years of practical experience behind it, had developed simplified methods for statistical quality control that any shop foreman or inspector could use, and was able to hand over to the other technical services and to industry through the War Production Board, the American Standards Association, and similar agencies time-tried methods for greater efficiency in production.

Quality control is an outgrowth of the research of Dr. Walter A. Shewhart of the Bell Telephone Laboratories. Although it came into being about 1924, its acceptance for practical use was slow—probably because it was considered too complicated. At Picatinny Arsenal a system of quality control based on the simple measure of variation—maximum dispersion (the artilleryman's bracket) instead of the more complicated statistic, standard deviation—was used successfully at a time when statisticians looked askance at such a bold use of this simple measure. Today it is in almost universal use both in the United States and in Great Britain. The procedure was so simplified that it could be reduced to five typewritten pages.

With the advent of World War II, the War Department requested the American Standards Association to issue war standards for quality control. Thus, ASA Standards Z1.1, Z1.2, and Z1.3 came into being. Subsequently, the War Production Board assisted in spreading the use of the quality-control methods by conducting classes for key industrial personnel in the larger industrial centers throughout the Nation. The ASA war standards were used as textbooks. The recently organized American Society for Quality Control is composed largely of the graduates of the wartime courses.

War production troubles were often traceable to poor specifications that could be remedied by quality-control methods. Many steel men regard the Ordnance specifications for gun-tube forgings as one of the greatest gains that the steel industry obtained from the war. The use of these methods in writing specifications for proximity (VT) fuzes contributed much toward bringing this important ordnance item to an acceptable standard of quality.

Whereas quality control is primarily a system for the economical control of quality of product during the process of production, a slight modification of the system, known as the "grand-lot scheme" (an Ordnance discovery), renders it applicable as an inspection method. Ordnance had worked out this system thoroughly by applying it for several years to the surveillance of war-reserve ammunition where it saved over fifty per cent of the cost of inspection and test while yielding much more information about the product than previously employed methods.

In the acceptance testing of tank armor during the war, the grand-lot scheme saved over two-thirds of the armor plate which would have been tested under existing specifications if this powerful method had not been employed. In like manner it was used to raise to a very high level the uniformity of mechanical time fuzes prior to the availability of the VT fuze.

Because industry used the quality-control techniques at least moderately, Ordnance was able to make exceptionally powerful use of them in sorting products to advantage. Just prior to the attack on Normandy it was decided that ammunition should be used which was so uniform that no dangerous artillery barrages would result from the changing of ammunition lots without trial fire.

An Ordnance team sampled a million rounds of 105-mm. ammunition, sorted it by categories based on ballistic characteristics, and regrouped the million rounds into what were essentially three calibrated ammunition lots. In a similar way, quality control was used to secure larger and more uniform lots of ammunition during manufacture.

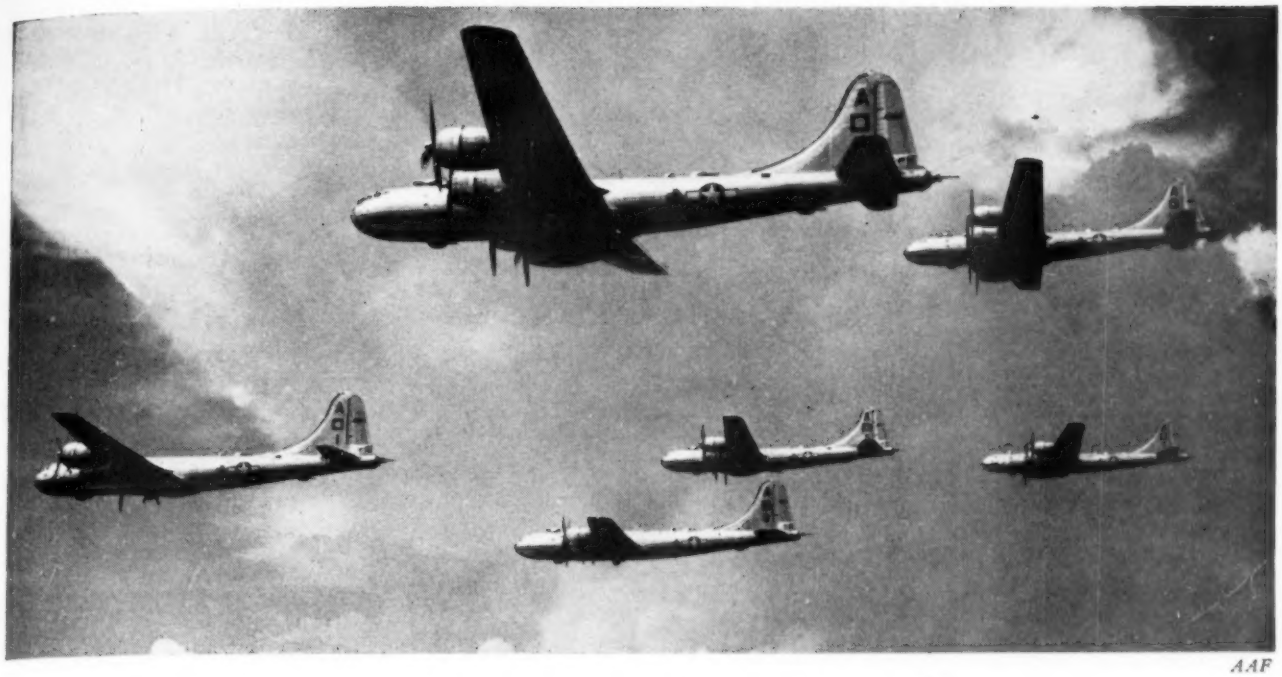
DURING the war, Ordnance used these quality-control methods extensively to shorten development testing and to check authoritatively on allegedly improved products. Instead of mere estimates that *A* is better than *B*, it was possible to express a probability value that *A* was better than *B* by *p* per cent. The economic success of this work is in part responsible for the increased use of scientific design of experiment by leading industrial firms today.

When inspection consists merely of identifying articles as good or bad, a method even simpler than quality control can be used to advantage, provided appropriate attention is given to the laws of probability. It is known as "single and double sampling." Whereas it does nothing to improve the product, it makes for economical inspection and encourages the manufacturer to use quality control to improve his product. In double sampling the inspector takes a small first sample which may result in (1) acceptance of the lot, (2) uncertainty, or (3) rejection of the lot.

In event of uncertainty—*i.e.*, the sample was neither very good nor very bad—a second sample is taken, and the decision is based upon the combined samples, the combinations of samples and lot sizes being so arranged as to keep the probability approximately constant of passing a lot of minimum acceptable quality. The majority of piece parts such as those for fuzes and ammunition components were accepted by these methods.

Like quality control, single and double sampling tables originated with the Bell Telephone Laboratories, but the stimulus to their wide use came largely from Ordnance.

Colonel Simon is director of the Ballistic Research Laboratories, Aberdeen Proving Ground, Md.



AAF

Preparedness for Air Power

Industry Should Be Ready for Full Production

by

Brig. Gen. John C. Gordon

Time will not be on our side in any future emergency in the air age

THE ability of our air forces to play a decisive rôle in the achievement of victory on the global front during the past war was founded upon the tremendous output of our industry.

For the three years—1942, 1943, and 1944—American aircraft production exceeded the combined production of its allies. Specifically, the United States produced 230,000 military aircraft while Russia was producing a reported 120,000 and Britain some 80,000 planes.

Today, the Air Forces are concerned with the time required to attain this tremendous wartime production volume. It can be positively assumed that in any future emergency this country will not have the same breathing space afforded in World Wars I and II to accomplish its production acceleration. Thus, peacetime planning for air industrial preparedness is a vital necessity, a sound national insurance program which will save invaluable *time* if and when needed.

Air industrial preparedness is that important segment of national industrial preparedness which concerns the program that enables American industry to produce an adequate volume of air weapons in the time required to assure national security.

Brig. Gen. John C. Gordon
Deputy Commanding General for Plans, Air Matériel Command, Army Air Forces, Wright Field, Ohio.

Air industrial preparedness involves coöperation and detailed planning among the Air Forces, the Ordnance Department, all technical services, and industry. It includes specific plans covering certain air weapons to ensure their rapid production in the event of an emergency. It covers not only conventional aircraft and components but also the latest jet, pilotless, and even atomic air weapons resulting from scientific research and engineering development.

The World War II production record of Army and Navy aircraft is shown graphically in Chart II. The *ordinate* is millions of pounds of airframe weight. (Aggregate poundage is a more accurate measure of aircraft production since plane units fail to distinguish differences in plane sizes varying from trainers to bombers.) The *abscissa* represents the time required for mobilization.

ALTHOUGH the aircraft-manufacturing industry received substantial orders from the British and French in 1939 and early 1940, the major impetus for volume production of aircraft began in June 1940 following the President's announcement of the "50,000-plane program." This goal bore no relationship either to actual orders for specific planes or to projected capacity, as the aircraft industry was then producing at an annual rate of only 6,000 planes, half of which were trainers. During the year and a half from June 1940 to December 1941, aircraft production, measured in terms of airframe weight, expanded sixfold. At the time of Pearl Harbor, our military production was at an annual rate of 120,000,000 pounds.

The chart shows the relationship of the major invasions—North Africa, Sicily, and Normandy—to the aircraft production curve. In June 1944, the aircraft

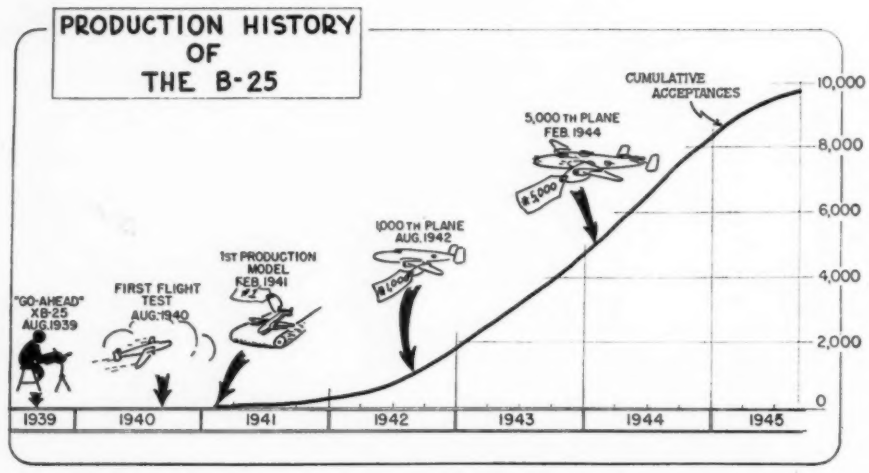


Chart I. It took about three years to get the B-25 into full mass production.

production rate reached its peak, representing nearly a fiftyfold expansion in four years. Thereafter to V-J Day, the curve reflects the irregular decline in total production, although the B-29 very heavy bomber program was in full swing during this period.

In the record war year of 1944, American industry produced 96,000 military planes with an aggregate airframe weight of 1,000,000,000 pounds, while in 1946, total Army and Navy acceptances were less than 15,000,000 pounds.

In planning any future industrial mobilization for aircraft production, certain fundamental facts learned from World War II experience stand out: (1) The average time lag from government "go-ahead" until the contractor reached volume production of a plane was 3½ years; (2) The average time lag from initiating construction on a new aircraft plant until the first airplane rolled out the door was 1½ years; (3) The specialized aircraft industry produced half of the total aircraft engines and accounted for ninety per cent of the airframes assembled (using their own fabrications as well as subassemblies produced by outside sources); (4) The desired volume of air weapons was reached only by utilizing the industrial facilities of the automobile industry and other large corporations, together with thousands of subcontractors, and thus, toward the end of the war, an ever-increasing proportion of aircraft and components was produced by other than the specialized aircraft industry; (5) Every plane and every engine which saw combat service was in development or on the drawing board *prior* to Pearl Harbor.

In other words, in nearly four years of war this country failed to complete the cycle of designing, developing, engineering, manufacturing, and combat testing a single airplane!

The backbone of the medium-bombardment effort in the China-Burma-India Theater, where the writer served, was the B-25 "Billy Mitchell" twin-engined bomber. In the heat of battle, one quite often underestimated the design, engineering, and production problems that had to be solved before such planes as the B-25 could become available in the quality and quantity required for combat.

The history of the B-25 typifies many of the fundamental problems of industrial mobilization and production acceleration. North American Aviation, Inc., submitted to the Air Corps, in June 1939, design proposals prepared in little more than a month. Upon receiving word in August that its design for a medium bomber had been accepted, the company hastily engineered and mocked-up the B-25. The prototype was completed and test flown in August 1940.

THE first production model was accepted in February 1941 from the Inglewood (California) plant, and thus the B-25 was one of the few combat planes in production on Pearl Harbor Day. Upon declaration of war, the Air Forces had approximately 150 operational B-25's. In April 1942, the world was electrified by the sensational Doolittle raid over Tokyo with a squadron of B-25's.

As part of the defense program to build "shadow" aircraft factories in the interior of the country, in December 1940 the War Department announced its plans for the construction of an airplane assembly plant in Kansas City and assigned the plant to North American for the production of 1,200 B-25's. The construction record was remarkable. Ground was broken in March 1941, the plant was completed in December, the first B-25 was accepted from the Kansas City plant in February 1942, and by December 1942 acceptances were exceeding one hundred planes monthly.

The over-all production record in 1943 showed an erratic acceleration. Inglewood production began to taper off because of higher priority given to the P-51 Mustang fighter. The production-acceleration cycle at Kansas City was interrupted by plant expansion and lack of machine tools, by reconverting from assembly to complete manufactur-

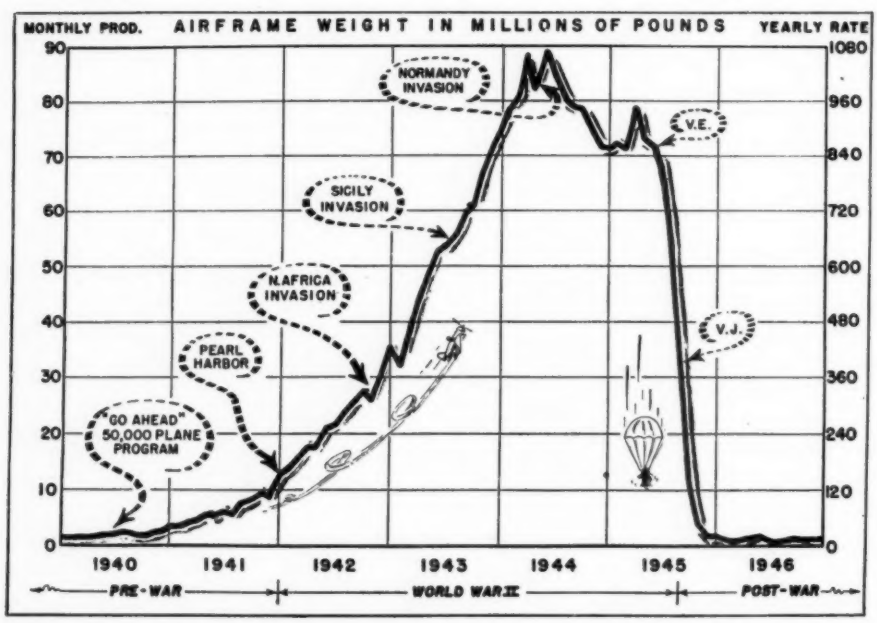


Chart II. U.S. World War II aircraft production exceeded the allies' combined total.

ing, and by virtual redesign of the plane.

In 1944 the production outlook became considerably brighter. By the time Inglewood produced its last B-25 in July, the rate at Kansas City had been pushed to more than 275 units monthly. The 9,816th B-25 was accepted on V-J Day, when all contracts were terminated. Chart I shows combined monthly acceptances of the two plants from 1941 to 1945 inclusive.

The production experience of the B-25 emphasizes the time required to obtain volume production of a combat-tested plane. The period from design initiation to flight test was fifteen months. First acceptance occurred six months later while an additional eight months were required to produce the one hundredth plane at Inglewood. The Kansas City timetable shows nine months to complete the plant after ground breaking, two months more for first acceptance, and five months additional for the one hundredth acceptance. The time span from design initiation to the five thousandth acceptance was fifty-seven months.

AAF

This B-25 is the most heavily armed plane of its class, carrying 18 caliber .50 machine guns, 12 of which are fixed to fire forward while 6 protect other vital areas.

Our present concept of air industrial planning is predicated upon four "keys." *The first key is an adequate research and development program that carries through production in limited quantities to provide production proving and service testing.* The research staffs of the Air Forces and of industry must have designs constantly available for the most advanced types of air weapons. There should be in production at all times at least one model in each critical type—a very heavy bomber, attack bomber, jet fighter, supertransport, pilotless aircraft, etc.

The "mobilization airplane" must remain in production until a new model is found acceptable and is made ready to replace it. In early 1945 we had the B-17 Flying Fortress going out of production, the B-29 Superfortress in volume production, and the B-36 designed with construction under way on its prototype. Our air industrial mobilization plans should be developed around aircraft actually in production, changing these plans as newer air weapons are proved and production-tested.

Thus, we must do more than make merely experimental versions of the latest and most effective air weapons. Design engineering and production engineering must be integrated. In other words, the plane model should initially be so designed that it could be produced in volume without subsequent redesigning. Blueprints cannot fly, nor can prototype planes win an air war.

A second key to air industrial planning is the maintenance of a healthy nucleus of an aircraft industry capable of rapid expansion supported by a program of continuing military production.

The Air Coördinating Committee, basing its findings on a series of comprehensive studies prepared in the past several years, recommends an annual procurement of around 3,000 military airplanes, with an airframe weight of some 30,000,000 pounds, to maintain a nucleus of a peacetime aircraft industry capable of meeting future mobilization requirements. This figure equals less than two weeks of peak war output.

This level of military procurement, coupled with commercial and private-plane production, would maintain the air-craft manufacturing industry during peacetime at a level from which accelerated production could be effected in case of an emergency.

As the third key of the air industrial plan, there must be an industrial reserve of production facilities and resources. A major problem involves the retention of certain large airframe and engine plants constructed by the Government during World War II. These plants should be considered as recoverable facilities necessary to our security program and therefore are being sold or leased only under special provisions prohibiting major structural changes and allowing governmental reëmployment within ninety days.

The plan provides for a reserve of machine tools in line with the recommendations of the Air Coördinating Committee. The Under Secretary of War has authorized the AAF to select 40,000 general-purpose machine tools from Government-owned stocks and place these tools in long-term storage. Approximately half of these tools have already been selected to date by the AAF, and the balance will be obtained through the joint Army and Navy tool-selection program.

The fourth key to air industrial preparedness is the undertaking of detailed industrial-preparedness measures jointly between the services and industry to keep certain of our latest air weapons in readiness for volume production.

In addition to the use of preparedness measures in those plants currently producing air weapons, considerable attention is being given to the problem of maximum acceleration in branch and licensee plants. Under this program, airplane manufacturers will provide a complete "engineering package" consisting of all necessary engineering drawings appropriate for volume production, reproducible loft layouts, reproducible master detail assembly layouts, and possibly even operation sheets and tool designs.

The implementation of these four keys will be reflected in both the actual and potential strength of our air forces in the event of an emergency. The first wave of enemy aircraft must be met by combat planes in the hands of our tactical air units throughout the world. In the intermediate period, replacements and additions in the desired quantities can come only from the aircraft actually in production.

In the final phase, our air weapons will be those which were in development, or at least on the drawing board, at the outbreak of the emergency.

Guided Missile Defense

Acme

War did many strange things to military researeh

by
Paul W. Martin

The nature of antiaircraft weapons has changed with the coming of supersonic rockets and jet aircraft

THERE are two great problems facing ordnance designers today. The first is the development of long-range, supersonic, accurate missiles capable of reaching any point on earth. The second is to find a defense against such missiles. The latter is a basic problem, one that has become of vital importance during the last quarter-century.

Ground-to-air defense (the term "antiaircraft" is no longer applicable with the advent of guided missiles and long-range rockets) is a new field in military science. It originated in the first World War when, for the first time, the airplane became potent enough to warrant special weapons directed against it. These special guns were standard ground artillery weapons fitted with crude high-angle mountings. Occasionally ground machine guns were used against low-flying planes. No efficient system of aiming these weapons was then known, and accuracy was deplorable. During World War I, over 18,000 rounds of ammunition were fired for every plane brought down.

In the twenty-odd years between World Wars I and II, ordnance experts were unable to develop antiaircraft guns equally as efficient as aircraft. Airplane speeds exceeded 300 miles an hour, air squadrons operated above 15,000 feet, attacking aircraft took advantage of darkness, cloud cover, and smoke. Gun calibers were increased and new shell fuzes developed, but it inevitably became evident that the real problem lay in finding an aiming system that eliminated the interrelated problems of tracking the aircraft, of height finding, of aiming the gun, and of fuze setting. Until such a system was found, antiaircraft weapons could not be efficient.

There were still other problems. Low-flying aircraft—dive bombers, fighter-bombers, torpedo planes—were becoming increasingly effective. Guns were needed that could put out a terrific amount of shellfire in the few seconds that such aircraft were in range. These shells had to be large enough to cripple a plane with a few hits. Again, until such weapons were developed there was to be no practical ground defense against air attack.

In this country, from about 1935 on, research divisions of the Army and Navy worked on the two problems of evolving an efficient detection and aiming method and developing automatic light and medium antiaircraft weapons. The most progress was made with the first problem. In 1936 a War Department directive gave the highest priority to the development of radio detectors for the use of antiaircraft batteries, and in 1937 the Army successfully demonstrated such a device at the Signal Corps laboratories at Fort Monmouth, N. J. It not only detected aircraft but also gave range, direction of flight, and elevation. The new device or, to be more

---

Mr. Martin is the author of numerous articles on military and scientific research and development.

Signal Corps

Caliber .50 machine guns in a power mount were a defense against strafing planes.

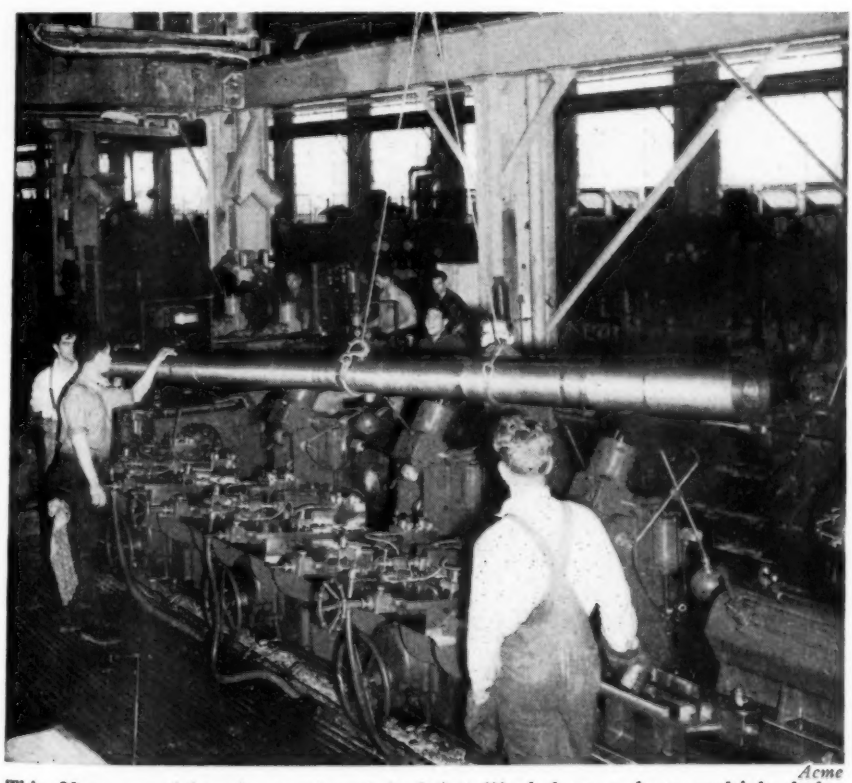
the final touches on the tactical plan for the attack on Pearl Harbor, and much too soon for the Ordnance men came war.

War brought home the realization that we had fallen dangerously behind in our antiaircraft program. For almost a year our forces had to employ outdated equipment, much of which was completely ineffective. The standard 3-inch heavy antiaircraft gun of our Army was ridiculously short-ranged. The 37-mm. was inaccurate and weak in hitting power. The Navy's 1.1-inch was even worse,—jamming frequently, unwieldy, and slow-firing. The heavy caliber .50 machine gun, which was the short-range weapon of both the Army and Navy, was not much better. In late 1942 the picture was a dismal one.

specific, the principle involved in the device was given the generic term of "radar." A great step forward had been made.

However, this was not so with the development of quick-firing antiaircraft guns. We were unable to overcome the inertia engendered by twenty years of almost total disarmament, and our first steps were halting and misdirected. The Navy prepared designs for a 1.1-inch automatic quadruple antiaircraft gun, and the Army used a 37-mm. gun on a mobile carriage. Both were totally inefficient. We realized this, but it was already 1941, the Japanese were putting

The 20-mm. Oerlikon gun was an automatic cannon of good efficiency and power.



Acme

This 90-mm. antiaircraft gun barrel is being lifted from a huge multiple lathe.

Then, when things looked as if they could not get much worse, they suddenly got better. A new, heavy, mobile antiaircraft gun, the 90-mm., began coming off the production lines in large numbers. A foreign-designed and already proved automatic medium-range gun, the Bofors 40-mm., appeared both in Army antiaircraft batteries and on naval vessels. Redesigned versions of the caliber .50 were put into service along with the new radar sets.

One especially was to be used in conjunction with the new electronic gun director which, in turn, had been developed for use with the power-driven and automatically aimed versions of the 90-mm. gun and for the heavy new 120-mm. then still in the design stage. It was the antiaircraft gunner's dream. It fed range, direction, height, speed, and all the necessary attendant data into the director which, in turn, automatically laid the guns. Accuracy reached a new high!

Next came the VT fuze. Working on a principle similar to radar, it brought antiaircraft accuracy to a point where, at the close of the war, we were averaging a "kill" for every twenty shots fired. The VT fuze had a number of disadvantages, among them its cost and its tendency toward premature bursts. But it was the final step in solving fuze setting—the last fundamental problem of antiaircraft defense.

By 1944 our antiaircraft defenses had reached a point where, for the first time, aiming devices were theoretically more accurate than the guns themselves. We were apparently ahead of the problem, and both the Army and Navy worked on designs for guns that could take full advantage of the newfound accuracy. Among these new guns were the Navy's twin 3-inch 50-caliber and single 3-inch 70-caliber guns, the largest automatic antiaircraft guns ever built.

The Army is working on similar weapons to replace the Bofors 40-mm. as the standard medium antiaircraft gun. Also being developed are some of the largest antiaircraft guns ever designed, including the Navy's rapid-fire 8-inch 55-caliber and a reportedly similar mobile Army weapon. These guns are to be entirely controlled by radar and capable of extreme accuracy at incredible ranges.

But they are already obsolete!

The war did strange things to military research. Intensified study caused enormous progress in some new fields, while older lines of development progressed normally.

We are still working on new types of aircraft, on ordinary artillery, and on chemical explosives; yet we now have weapons that make these obsolete. The two most advanced of these are guided missiles and the use of atomic energy for military purposes. In these two fields can be seen the pattern of future warfare.

When Germany fell, designs for a 2-stage rocket, capable of crossing the Atlantic, were found. In its original design, the rocket was too small to carry the bulky cylindrical mass of the atomic bomb in its war head. The principle was sound, however, and it could have been enlarged to carry an atomic war head. American scientists are now working on a stub-winged rocket that is to be fired into the upper levels of the earth's atmosphere to circle the earth until brought down on its target by radio control. Russia has developed swift, low-flying, heat-sensitive and light-sensitive rockets.

Signal Corps

Low-flying planes feared the 40-mm. antiaircraft gun.

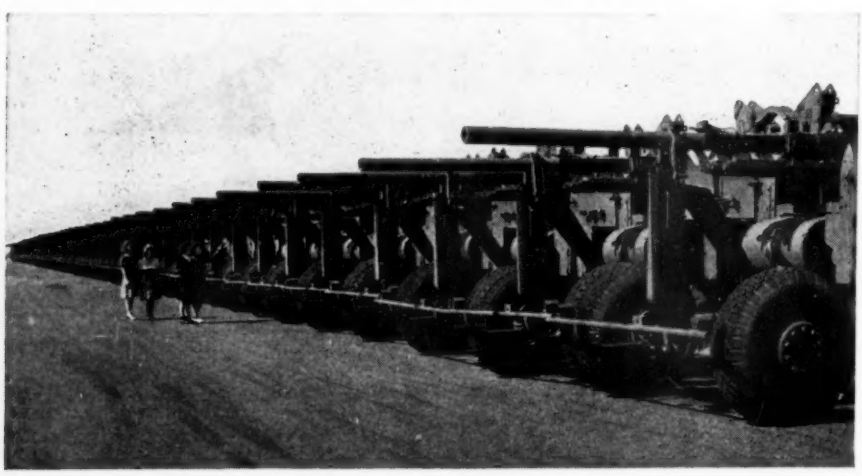
It is with weapons of this type that we must reckon in case of a future war—weapons spanning enormous distances and carrying atomic war heads. This is not "scare" propaganda. The development of these rockets is now feasible; in a few years it will be practical. And it is these weapons that give the science of ground-to-air defense its present enormous importance.

There would be three stages inherent in the interception and destruction of an enemy guided missile carrying an atomic war head. First there is the detection of the rocket at a sufficient distance to enable the defense forces to take measures against it. Secondly, a defensive rocket must be launched on a course that would come as close as possible to that of the oncoming missile. Thirdly, the actual destruction of the missile by the defensive rocket must be done at a safe distance.

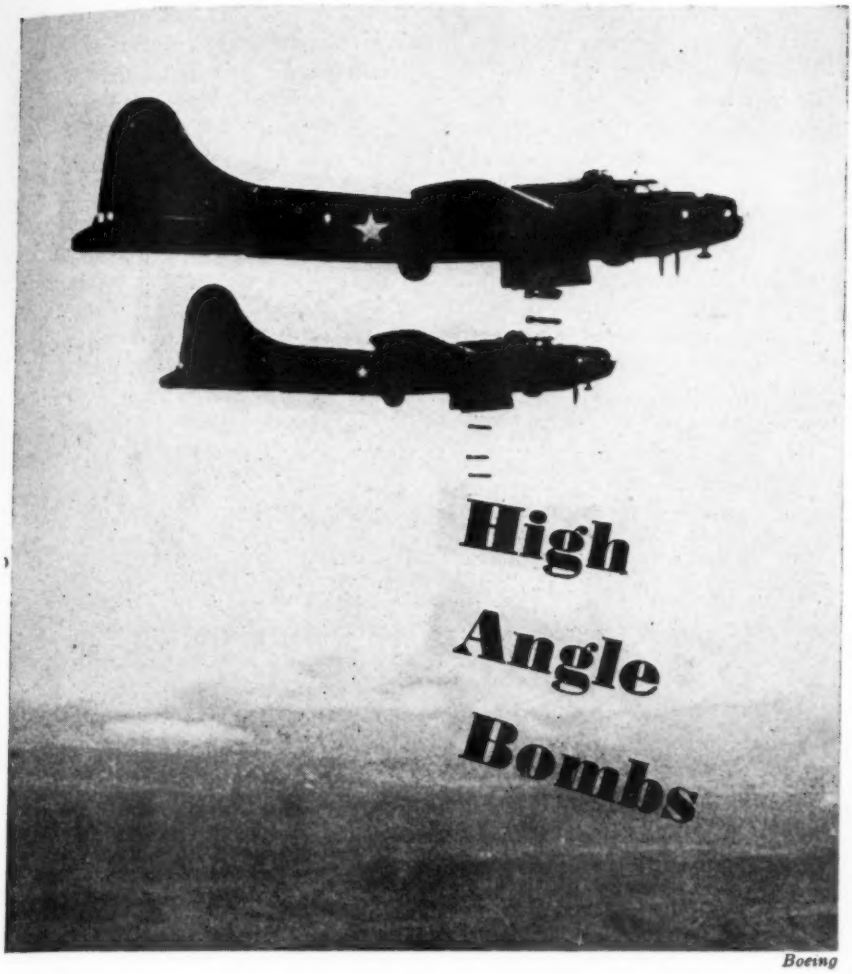
These problems are not insoluble. Primary detection could be accomplished by a standard early-warning radar set, but it would have to be at a much greater distance than the effective range of radar detection units today. A network of early-warning radar sets surrounding our country would be necessary. Inside this network would have to be the defensive rocket launchers, each launching area with its tracking and range-finding radar. These would pick up the missile and send a rocket on an intercepting course.

But, if this was done, the enemy could send over a thousand rockets, of which only a hundred carried atomic war heads. We would have no way of discovering which were which, and it would be necessary to intercept each rocket individually—an all but hopeless task with so many missiles. The enemy could employ radar jamming devices which would make it impossible for the intercepting missile to "home" on its target. He could send escorting, high-speed rockets with his atomic missiles to intercept and destroy defensive weapons. And, finally, no defensive system has ever been one hundred per cent effective. Some of the rockets are bound to get through.

This, then, is the new problem. On its solution may depend the future of our country.



Antiaircraft weapons such as those above will be made obsolete by supersonic war.



Boeing

Excellent Accuracy Was Achieved Guiding Missiles by Radio Control

by

L. O. Grondahl

National Defense Research Committee scientists have made an old idea practical

A STUDY of the possibility of correcting errors in high-angle bombing was begun in 1940 by a small group of scientists at the Massachusetts Institute of Technology with the support of the National Defense Research Committee. The basic idea had been proposed even before World War I but had not been made practical before the problem was undertaken by the N.D.R.C.

In the analysis of the problem, it is soon realized that in order to eliminate the errors in high-angle bombing it is necessary to control both range and direction. In the early stages it was decided to base control on a rectangular coördinate system moving with the bomb, thereby controlling the flight of the bomb in azimuth by means of rudders and the range by means of elevators.

This method of control obviously required that the bomb must not be allowed to rotate about its own axis during flight. The rudders always had to be kept vertical and the elevators horizontal to get the proper response when controls were applied. Radio was decided upon as the only practical linkage between the plane and the bomb. The following questions immediately presented themselves:

(1) Is it possible to control a high-angle bomb sufficiently to correct the errors that are likely to be encountered? When dropped from 15,000 feet altitude the bomb might miss the target by a few feet up to several hundred or even occasionally a thousand feet. (2) What kind of aërodynamic surfaces must be used in order to get the necessary control? (3) What physical shape should a controlled bomb take? (4) What is the behavior of a bomb in its flight to the ground?

THE following control systems were proposed: (1) Use of television in the bomb to transmit to the operator deviation from the true course of the bomb and the application of corrections by radio. (2) A target-seeking apparatus which could be used to direct the bomb automatically. (3) Direct sighting of the bomb which could be watched from the airplane and steered manually by radio.

The earliest experiments were made with small models in the wind tunnels at M.I.T. which indicated that the controls would be adequate. In order to verify the results and the very large extrapolation that was necessary, 100-pound practice bombs were taken to the Aberdeen Proving Ground and tested to determine their behavior in the air. By direct observations from the plane and from the ground it was determined that most of the bombs rotated so rapidly that it was very difficult to get even an estimate of the effects of the rudder surfaces.

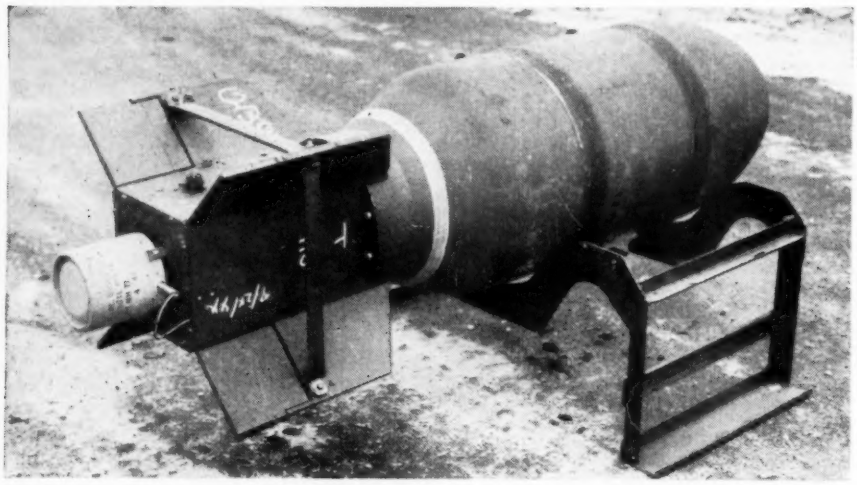
Occasionally a bomb was dropped in which the rotation was small enough to give promising indications. The conclusions were that control by means of rudders was feasible and that gyro stabilization was absolutely necessary. It also was learned that in order to see the bombs well enough to control them from the air it would be necessary to provide them with tail flares.

The early work at M.I.T. consisted in the development of the aërodynamics of the bomb bodies and the assembly of the essential apparatus for three types, namely, those with television, target-seeking, and direct-sight controls. Television bombs were built with thin shells

Mr. Grondahl is director of research and engineering at the Union Switch and Signal Company and was a member of the National Defense Research Committee.

and with practically all the space occupied by the television apparatus.

AT ABOUT the time that these units were approaching completion for field test the Gulf Research and Development Company came into the project under contract with N.D.R.C. Soon thereafter the entire development program was transferred to the Gulf Laboratories. There was then developed a more adequate method of experimentation in the field. Cameras for taking moving pictures from the nose of the bomb were built, and, with the use of flares, motion pictures were also taken from the plane. Clockwork mechanisms were developed and used to provide a predetermined schedule of controls.



The white container on the tail structure is a powerful flare for visual sighting.

Parachutes were used to save the apparatus as much as possible.

The moving pictures taken from the nose of the bomb and from the plane made it possible to analyze the trajectory. The pictures showed how the bomb responded to aileron control, how much yaw or pitch was involved in the application of the controls, the period of oscillation of the bomb in yaw or pitch and in rotation, the rate at which the bomb responded to control, and many other details that were necessary for the solution of the problem.

With the direct-sight missile, the control in range is very difficult. In order to control range and azimuth without the use of additional apparatus, it is necessary to maneuver the plane so that the bomb can be silhouetted over the target. Since in normal flight the bomb, as seen from the plane, always appears to be well back of the target, this coincidence can be obtained only by the sharp reduction of the speed of the plane. This reduction had to be made during the first ten seconds or so after the bomb was released.

By putting the plane into a very steep climb with the throttle retarded, speed was reduced from 220 to 120 miles an hour. After this the plane continued at its reduced speed in the direction of the original bombing run, and it was then possible to hold the bomb on the straight line connecting the plane and the target. The special maneuver was undesirable, and it was later found possible to develop instruments that made it unnecessary.

The essential details of the television bombs, target-seeking bombs, and direct-sight bombs of both the Azon and Razon types had been completed before early experiments at Eglin Field. As far as the direct-sight missiles were concerned, equipment included a radio receiver with codes for right, left, or "no control," gyro equipment for stabilizing the bomb, a battery, the necessary servo motors for controlling the deflecting surfaces, and solenoids for controlling the ailerons. A chemical flare with match ignition was used. For rudders, elevators, and ailerons, portions of the trailing areas of the regular tail fins were used.

The gyro equipment deserves special mention. It consisted of two gyroscopes, one called a free or directional gyro and the other a rate gyro. The free gyro was used to return the bomb from any position at which the rudders were not vertical, and the rate gyro was used to keep the speed of rotation of the bomb below a certain value. The directional gyro alone would return the bomb to its normal position with such high angular velocity that it would overshoot its course and go into violent oscillations. With the rate gyro coöperating, it did not overshoot by more than about three degrees and quickly settled down to stable flight.

Early in 1943 it was realized that it would not be possible for us, in a reasonable length of time, to develop all the types of bombs that had been started. It was therefore necessary to get a decision from N.D.R.C. as to the direction that should be followed in our work. A meeting of Division 5 and Section 5.2, together with a great number of representatives of the armed forces and of other interested organizations, was called. The section chief presented the situation and recommended the development of direct-vision bombs.

Pilots, bombardiers, and, to some extent, the aërodynamics experts thought that such a development was not practical, and it was finally concluded that the most promising development lay in the target-seeking units. The section was instructed to devote its efforts to that type of bomb.

Following the meeting, it was necessary to get additional aërodynamic data, and an attempt was made to do that by means of the Azon bombs that were ready for test. Some of these units performed very well, and in one case a very satisfactory moving picture was obtained of a drop in which the bomb, as seen from the plane, was made to follow a road and finally hit on the road which was only twelve feet wide. The bomb was dropped from 15,000 feet and the correction available from this altitude was about 2,500 feet.

THE moving picture was taken to Washington and shown to interested Army officers. After seeing what could be done with direct-sight control, these Army officers at once concluded that the Azon development should be completed and that we should immediately go into production. It was realized that the Azon would be a very effective weapon against long targets such as roads and bridges. All subsequent effort was confined to direct-sight controls.

The changes from the experimental unit that were necessary for production and for use in the field are briefly stated below.

The body of the tail structure was changed from a round section to a square section of a welded construction integral with the fins. The whole struc-

ture was equipped with the standard sleeves of the 1,000-pound general-purpose bomb.

The gyroscopes were changed from air-driven, vacuum-operated to electric drive. This was done in order to provide more ample torque and easy detachment from the plane.

The 12-volt battery was changed to a smaller 24-volt battery. This made it possible conveniently to warm up the equipment in the ship.

Solenoids were changed to reduce mechanical linkage and to reduce the power requirement.

A superregenerative radio receiver was used. Selection of functions was changed from the long and short pulse code to audio frequency modulations. Later the radio was changed to a superheterodyne.

THE antenna used in the experimental units was a wire supported outside the normal over-all dimensions of the tail. In the production model the struts which were installed to stiffen the fins were used also as antennas, being streamlined and brought inside the circumscribed square.

The servo motors were changed to twenty-four volts with higher speed and more complete noise suppression.

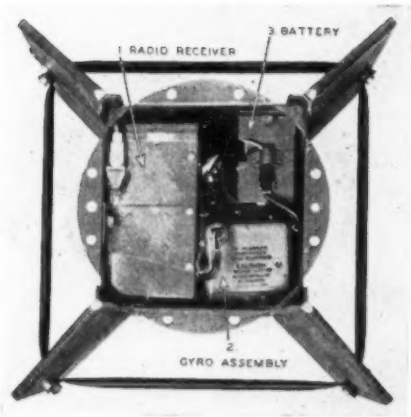
The circuits were modified by adding a switch and a coupling which enabled the equipment to be operated from the ship's power while in flight and to be transferred easily to the battery when the bomb was released. A protective relay was added to prevent the ignition of the flare until the bombardier had operated a switch after take-off. An electric gyro release was added.

The flare ignition was changed from a match to an electric squib and, through efforts of Army Ordnance, the over-all dimensions of the flare were reduced and its chemical behavior was made more reliable.

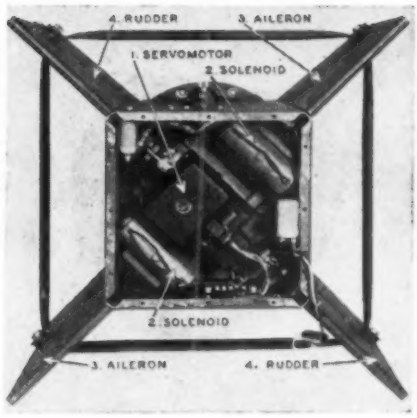
The disposition of the apparatus in the tail structure was changed so that each part was easily accessible for removal.

One hundred and fifty units of this type were built on a pilot production order. The first of these were delivered on November 25, 1943, and were immediately tested at Eglin Field. All except approximately thirty of the pilot production were used in combat.

The first delivery of regular production models was made March 27, 1944, and a squadron of B-17's of the Fif-



The Azon's gyroscope is electrically driven to provide more ample torque.



These solenoids reduce mechanical linkage and also lessen the power requirement.

teenth Air Force took the Azon into combat in February 1944 in Italy. During the Italian campaign some bridges were destroyed, and at one time the viaduct leading to the Brenner Pass was put out of service.

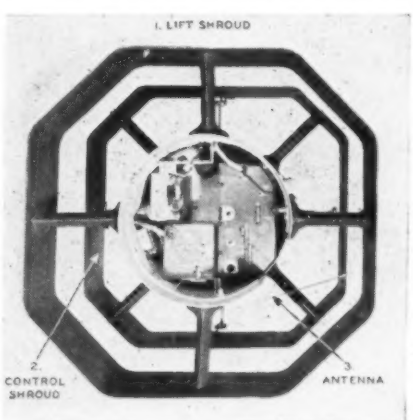
The next use of the Azon was made in France by the Eighth Air Force operating from England. Here also a number of bridges on the Loire and Seine were destroyed.

The really effective use of the Azon was made in Burma by the Tenth Air Force. Here there were not only adequate equipment and trained crews but also Army representatives and civilian representatives who were well trained in the use of Azon. Results in Burma were very gratifying. Approximately 150 bridges were destroyed, the result being a complete disruption of the Japanese communications.

While this was going on, the development of the Razon was completed.

In the case of the Razon it was found profitable to go to a different type of tail construction.

The cruciform tail structure was not abandoned but was set aside for the moment on account of the possibility that it might require more extensive development. The structure that was finally adopted for the Razon, known to the Army as VB-3, had aërodynamic surfaces in the form of two shrouds built in the shape of squares with broken corners. One may be called a lift shroud and the other a control shroud.



The Razon has two shrouds, one for lift and one for directional control.

The control surfaces were built as flaps on the trailing edges of the long sides of the control shroud. The ailerons were built into the struts supporting the control shroud and were four in number.

The results of the field tests with this unit were highly gratifying. The range control added to the azimuth control made it possible to hit short targets with a very much higher degree of accuracy than was possible with the Azon.

Corrections that were applied to compensate for the extra drag resulting from the controls still further reduced the range error. The average error from 15,000 feet was then found to be approximately 45 feet. The error in azimuth from this altitude was usually less than fifteen feet.

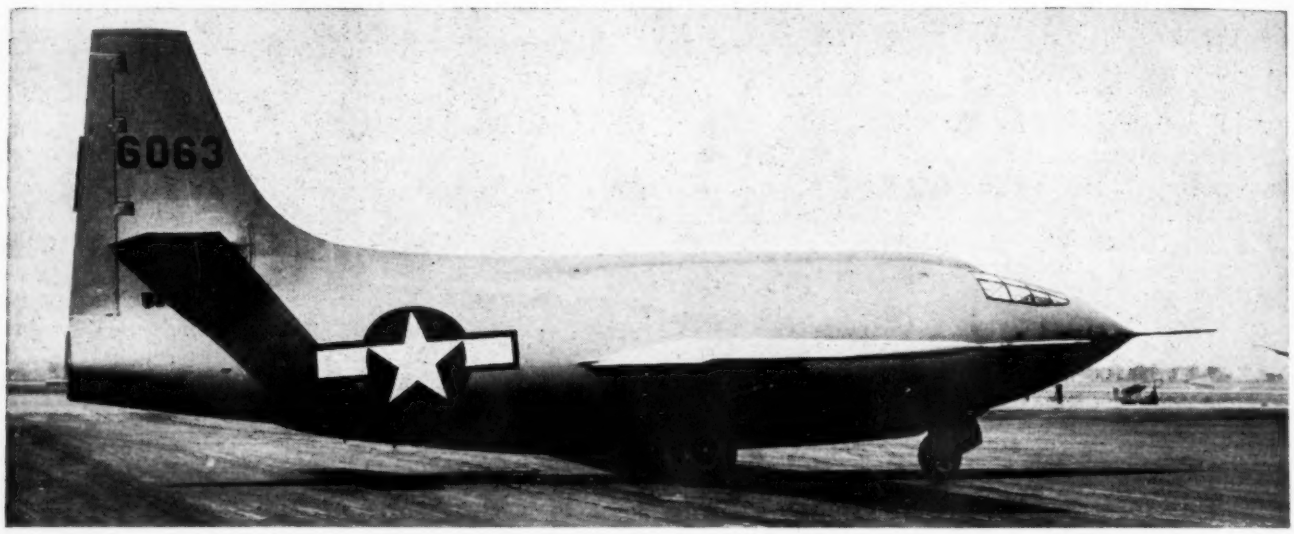
Since the components that had been developed for production of Azons were used in the experimental Razon, the engineering required for production was very much reduced.

The total construction of high-angle guided missiles was as follows: VB-1, 15,271; VB-2, 132; VB-3, 3,150—Total, 18,553.

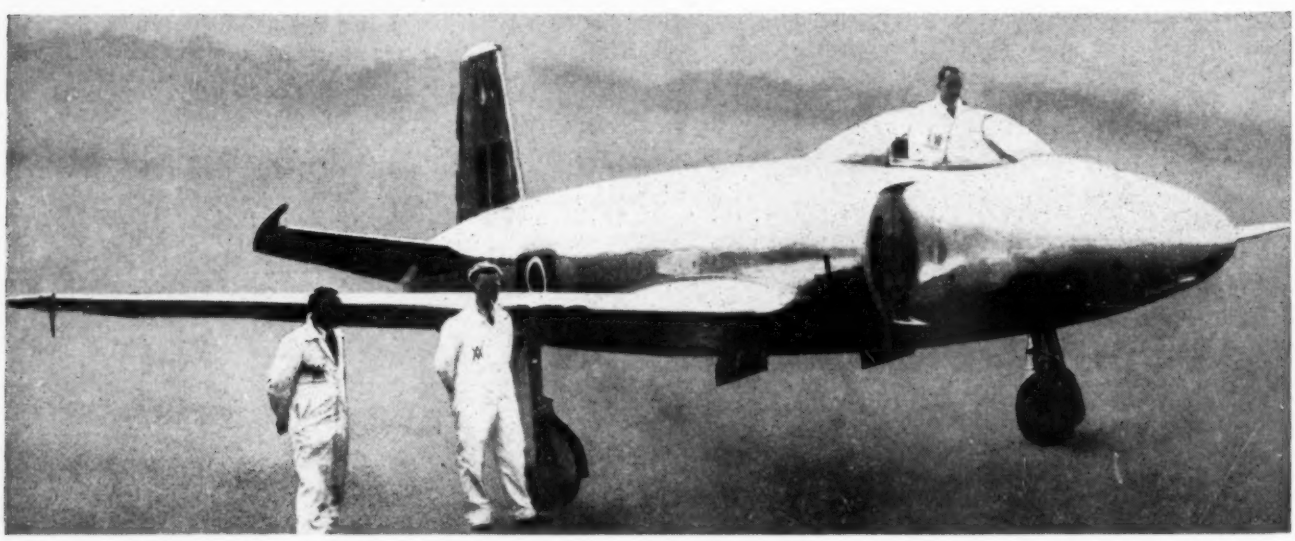
The foregoing story is an illustration of close and effective coöperation among a great number of organizations of highly diversified nature under the direction of the National Defense Research Committee to produce a result that was of value in combat.

Jet and Rocket Fighter Planes

The P-80 Shooting Star, above, leaps into the sky under the thrust of powerful Jato units, detachable rockets which whip the jet-propelled craft into the air in about 40 per cent of the normal take-off distance usually required by this type of plane.



The XS-1, the Army's first rocket plane, was designed to reach a top speed of 1,800 miles an hour at 80,000 feet with a rate of climb of about 45,000 feet a minute. It successfully completed its initial power-flight tests last year (Air Forces photo).



This new British jet fighter built by Vickers-Armstrong has a Rolls-Royce Nene I direct-thrust jet engine, a laminar flow wing, and a pressurized cockpit with a pilot-ejector seat. It is in the "better than 600 mile an hour" class (British photo).

Signal Corps

Task Force Frost

Cold-Weather Starting Devices Were Developed for Ordnance Vehicles

by

Capt. A. M. Kamp, Jr.

IN JULY 1946, Secretary of War Patterson testified before a Senate appropriations subcommittee that failure to conduct cold-weather tests during the winter would endanger proper performance of duty by troops in event of "serious emergency." Early in 1946, therefore, Gen. Jacob L. Devers, commanding the Army Ground Forces, decided that in the interests of national security, special winter equipment tests should be held. The sites selected for these tests were Ladd Field, near Fairbanks, Alaska; Adak Island in the Aleutians; and Camp McCoy in Wisconsin.

At Camp McCoy, where Task Force Frost assembled, winter temperatures of freezing to zero are not infrequently broken by short stretches when the mercury drops to 25 or 35 degrees below. This weather has been compared to that met by American troops in the Ardennes and is similar to the kind found in most Northern European countries.

The purpose of the winter operations at Camp McCoy was to obtain additional information on the performance of Ground Forces equipment under winter conditions, to make this knowledge available to Army Ground Forces boards, and to determine the proper equipment, tactics, and technique necessary to permit troops to function efficiently under heavy winter weather and cold-wet conditions.

Basic data is needed on equipment requirements under climatic extremes in order to guide development of improved, normal, and special equipment. During the war, considerable development took place to fit Ground Forces equipment for service in such extremes, but the work was incomplete for many items. In accordance with the request of the Commanding General of the Army Ground Forces, tests of equipment under winter conditions were approved and were conducted during 1946–1947.

The winter of 1944–1945 saw the American armies well on their way into Germany. Aachen had been taken and preparations were being made to cross the Roer River at Julich. In the meantime, Von Rundstedt was preparing to put everything into one big push to rout the American armies. This push drove a deep salient into the American lines, resulting in an all-out offensive. But by February 1945 the line had been straightened out, marking the beginning of the end of the *Wehrmacht*.

During the Battle of the Bulge, numerous difficulties arose over the operation and functioning of weapons, tanks, prime movers, and communications. Ordnance units in all echelons became swamped with artillery pieces that had leaking recoil mechanisms. They were harassed with innumerable questions as to how drivers could conduct preventive measures ensuring the immediate starting of motors. Field expedients in many cases did not serve the purpose, and many problems could not be solved because of the variability of the elements.

The Ordnance Department, after reviewing the numerous reports received from combat units, began extensive research so that plans could be drawn up for the modification and development of those items of equipment that were found to be inadequate in extreme cold and under wet-weather conditions.

The need for an "overcoat" to keep vehicle motors warm so that they might be started rapidly in the cold, led the Ordnance research group back to the winter of 1943. At that time, organizations stationed at Pine Camp, N. Y., received kits for installation in vehicles to aid starting in cold weather. The kits were incomplete to the extent that most of the materials used in constructing them had to be combined in the field by individual units.

Several of these kits were installed in vehicles but were found to be very dangerous, and several vehicles caught fire due to a mixture of gasoline and oil getting on the engines. Efforts were made by the units to correct this situation, but to no avail. As a result, they discontinued mounting the kits and carried on without them.

From these extinct kits Ordnance has developed two units that were tested by Task Force Frost. The auxiliary cold-starting kit (commonly termed "slave kit") is designed to provide an auxiliary source of electrical energy and heat to aid in starting the engines of cold vehicles or vehicles whose batteries are discharged. The unit can also be used for battery charging in emergencies.

The kit consists of eight 2-H, 6-volt batteries; a Homelite generator as a

Captain Kamp, a Field Artillery officer, was on duty with Task Force Frost at Camp McCoy, Wis.

source of auxiliary power and for charging the kit batteries; a voltage regulator; a Petro heater; and a switch panel for delivering six, twelve, or twenty-four volts, depending upon the voltage of the vehicle being started. In addition, the kit carries all necessary wiring accessories, control mechanisms, fuel tanks, and stowage compartments. The kit, complete, may be mounted in any organizational transportation with minimum pay-load capacity of 1,000 pounds.

The eight 2-H, 6-volt storage batteries are wired through the switch control panel in a series-parallel hookup. These batteries are kept charged by means of the Homelite generator.

THE Homelite generator consists of a single-cylinder 2-cycle gasoline engine directly connected to a 24-volt direct-current generator. This unit serves as a source of 24-volt power for charging the batteries and operating the Petro heater when other voltages are being taken from the switch panel and as an auxiliary source of 24-volt current when the demand on the unit is for a current of this voltage.

In addition to serving as a source of electrical power for the unit, the generator unit is also a source of heat for warming the batteries. To accomplish this, heat is led by means of a duct from the cylinder of the unit around the exhaust pipe and to the battery box. By heating the batteries, their temperature is brought up to the point where they can take an adequate electric charge. A battery will not absorb an adequate charge until it has reached a temperature of approximately plus 35 degrees Fahrenheit.

The Petro heater serves as a source of auxiliary heat for warming up the engine or any other vital parts of vehicles which are being aided by use of the kit. Heat is conducted to the vehicle in question by means of a 20-foot section of 3-inch flexible tubing. The heater consists of a blower, a fuel pump, a fuel-injection nozzle, ignition system, and a combustion chamber.

Mechanical and electrical power is supplied by means of a motor-generator unit which supplies mechanical power to the blower and the fuel pump and electrical energy for the ignition system from the generator side of the armature. In operation, the fuel is injected under high pressure by the fuel pump through a spray nozzle into the combustion chamber. Here it is ignited by the continuous spark supplied by the ignition system and burns in the stream of high-velocity air from the blower. The blower supplies both air for combustion and excess air which is heated and conducted with the products of combustion to the vehicle.

The Petro heater is a 24-volt unit and may be operated from the batteries when the switch panel is in the 24-volt position. When any other voltage is being taken from the panel, the generator is the source of power for the heater.

The switch panel provided with this unit has three outlets for plugging in "jumper" lines to connect with the vehicle being started. There are two multipole switches and one single-pole switch on the panel. The three voltages of current are made available by placing the multipole switches in various combinations of positions. The single-pole switch operates the heater, either from the battery with the other switches in the 24-volt position, or from the generator when the switches are in position to give voltage other than twenty-four. The jumper cables have adapters which will fit only the voltage outlet that the cable is supposed to carry.

Two fuel tanks are provided. One, which must contain lubricating oil, supplies fuel for the generator, and the second is for the Petro heater, which operates on regular motor gasoline or winter-grade Diesel fuel.

The heat duct is attached to the outlet opening in the Petro heater combustion chamber by means of a pin. By the use of this tubing, it is possible to direct hot air to a cold engine to warm it up and facilitate starting.

In temperature under 25 degrees below zero, the kit is an asset to vehicle operators. Quite simple to maintain and operate, it can be left in the open without fear of starting difficulties on cold mornings, since the heater unit can be used to warm the battery-charger engine. However, this method is comparatively slow, since the basis of issue is one slave kit for every thirty vehicles.

Taking this into consideration, the "gadget men" decided to continue working on a system whereby each vehicle, wheeled or tracked, would have its own "overcoat." A kit was developed and is known as the "winterization kit." It is installed as part of the vehicle and varies somewhat for each type.

All wheeled vehicles have a cab heater of the hot-water type and battery connections with a female plug to take current from the slave kit. A hand-operated fuel pump (primer) is also installed to inject a spray of raw gasoline into the intake manifold. The heart of the kit is a gasoline heater of the wickless type. The engine coolant is heated by means of a flat coil mounted above the heater. The top of the coil is the base of the battery box. Mounted in this manner, the heater unit facilitates heating the motor of the vehicle, the engine coolant, and the battery.

All task force vehicles were equipped with the winterization kit. Daily reports were submited by vehicle operators, and these reports were evaluated by motor officers and Ordnance officers of AGF Board No. 2, Fort Knox, Ky. The reports will be integrated with those of Task Forces Frigid and Williwaw and will then be evaluated by the Army Ground Forces.

Signal Corps

A "slave kit", mounted on a one-ton trailer, is used to heat a jeep engine.

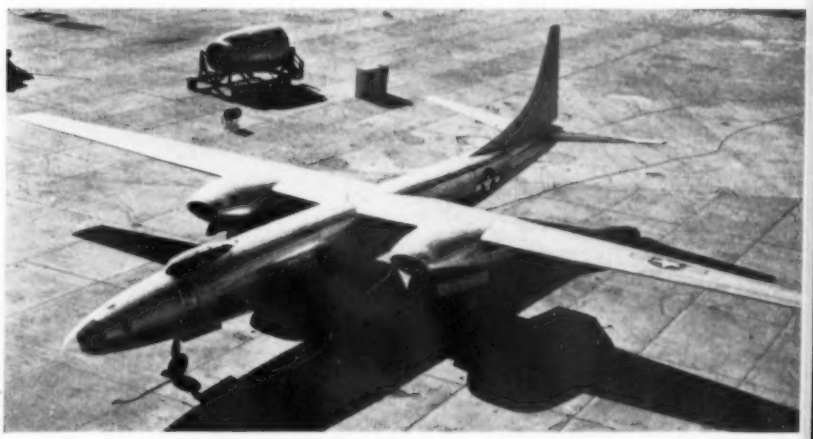
America's Airpower

The aircraft shown on these pages are indicative of the great ability of American designers and manufacturers. Under the impetus of the past war, America now leads the world in almost every field of aëronautics, made possible only through the productive capacity of our industry. It will require the energy and vigor of our builders to retain the leadership in this vital source of American strength and security.

The XB-36 is the world's largest bomber. With a 230-foot wing and six 3,000-horsepower engines it can lift 30 tons.

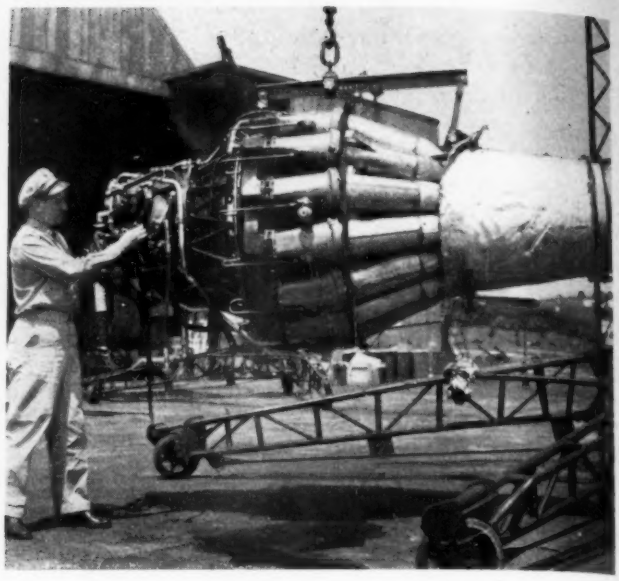
The Northrop XB-35 "flying-wing" bomber, with a span of 172 feet and a length of 53 feet, can carry a 10,000-pound bomb load 10,000 miles.

The XP-81 is powered by a jet engine and by a gas turbine driving a propeller, using exhaust for additional thrust.

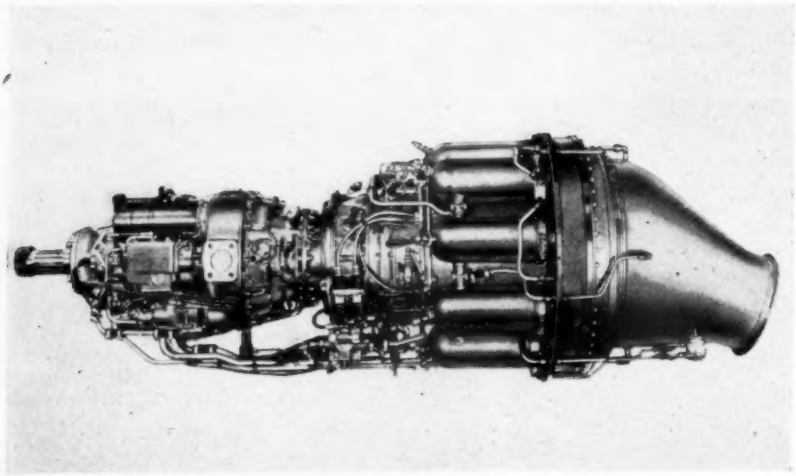


A new medium bomber, the XB-46 is powered by 4 turbo-jet engines, 2 in each nacelle. This airplane has a wing span of 113 feet and is 105 feet long.

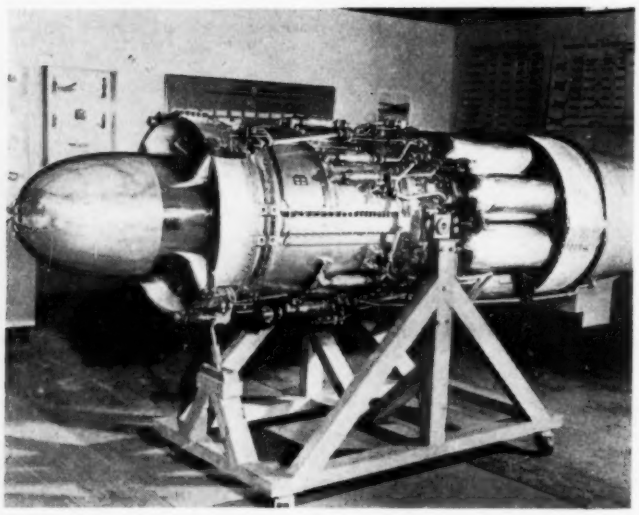
The new P-80 will have greater firepower, water injection to increase engine performance, and cockpit refrigeration.



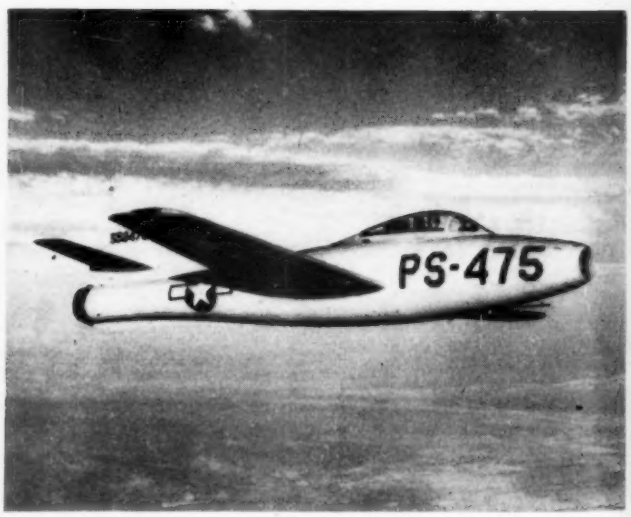
Compactness of the jet engine is a fundamental virtue; P-80 engines can be changed and ready for flight in 32 minutes.



The TG-100 gas-turbine engine combines jet propulsion and rotational energy to spin a propeller incorporated in one unit.



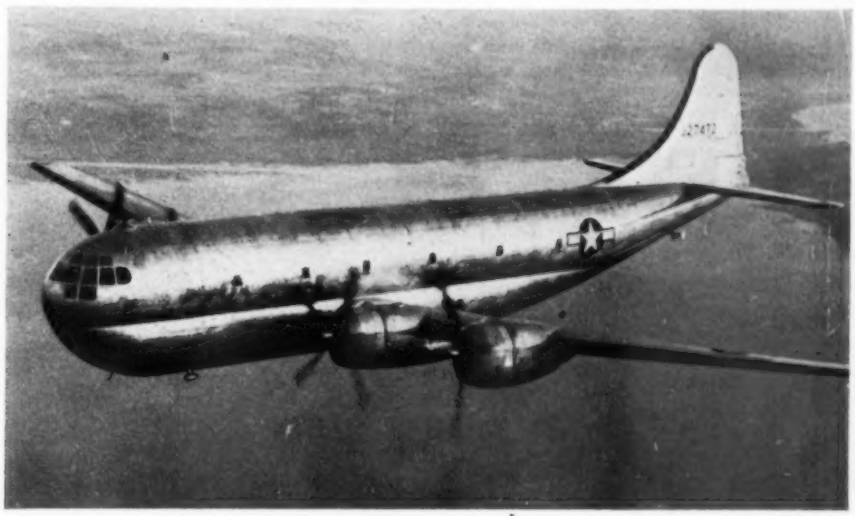
This streamlined jet turbine has such a small frontal area that it will fit snugly into the wing of a large transport.



The XP-84 Thunderjet with its air intake in the nose, has a span of 36 feet, a length of 37 feet, and 1,100-mile range.

Ribbon parachutes now can lower a 2,240-pound howitzer. Here the extraction chute pulls the cargo from a C-82.

A 90-foot parachute supports the howitzer. Smaller chute provides stability.

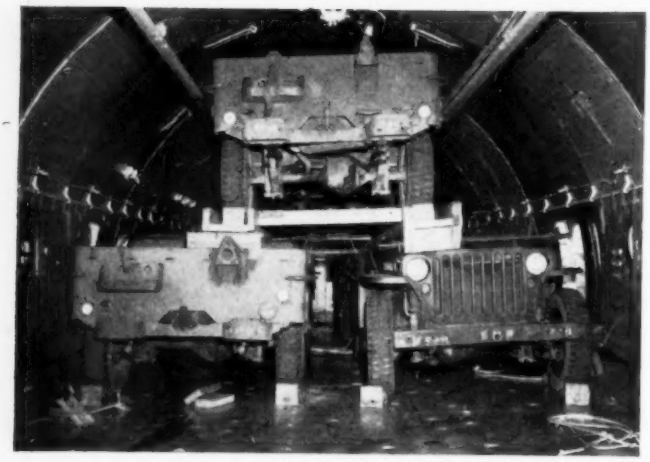


The YC-97 is a new transport evolved from the B-29. With 141-foot wingspread it has a speed above 300 m.p.h., a 4,000-mile range, and a 30,000-foot ceiling.

An Army truck comes down the ramp from the commodious fuselage of a C-97, giving some idea of the size and carrying capacity of this huge airplane.

The C-74 (left) is the largest land-based transport aircraft in the world. The plane has a wing-spread of 173 feet, an over-all length of 124 feet, and a speed above 315 m.p.h. The plane will accommodate all the jeeps shown lined up under the fuselage.

The cargo compartment of the C-74 is equipped with 3 elevators, each one capable of lifting 16,000 pounds, and a cargo boom to permit loading from the ground level. With the interior measuring 75 feet long by 12½ feet wide, 125 troops or 115 litters for wounded can be accommodated easily.



Fifteen jeeps can be easily fitted into the cargo section of the C-74 and have additional room for accessories. A total load of 45,000 pounds can be accepted in the compartment. With a range of more than 7,000 miles, the 4-engined aircraft can easily travel at speeds up to 315 miles an hour.

A descendant of the Army's most dependable transport planes is this C-54E. During World War II, the C-54 was an outstanding carrier with a performance unequaled in its class. Measuring 117 by 94 feet, the huge airplane can lift 10,000 pounds or 45 men.

AAF photos

Smashing the Atom

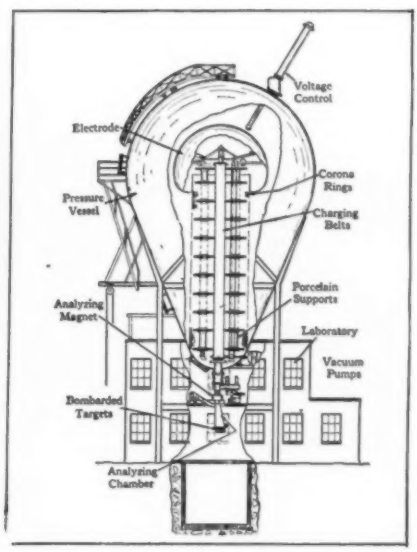
Bigger and Better Machines for Nuclear Research

Harold M. Shaw

Atom smashers are no longer considered scientific playthings but have been developed to be used in laboratories as standard and practical equipment.

ATOM SMASHERS have graduated from oddities to standard research tools. More than that, at least one of the recently developed atom-smashing machines has immediate industrial applications. University and industrial research laboratories are vying with each other to produce larger, more powerful, and new kinds of machines for blasting the atom apart.

Collectively, these machines are referred to as "particle accelerators." Basically, they all do the same thing—take a particle, usually smaller than atomic size, and speed it up so much that when it strikes an atom the force of the collision will pry loose a few particles from the atom. There are at least four different methods of doing this, employing four kinds of machines.



At left is shown the exterior of the Van de Graaff generator while the cutaway drawing, right, outlines the complexities of design in this 4,000,000-volt machine.

One of the earliest types of particle accelerators and one still in active use is the Van de Graaff generator, named for its inventor, R. J. Van de Graaff of the Massachusetts Institute of Technology. This has been called the pressure-electrostatic or belt-type generator.

This machine consists essentially of a large, pear-shaped steel tank, containing air under pressures ranging from 60 to 120 pounds per square inch. Raising the pressure increases the obtainable voltage because it increases the dielectric strength of the insulating air. An electric charge is carried from a generator at the base of the tank by two belts running up to the electrode, which is a big metal semisphere. The charge accumulates on its outer surface, creating a high potential between electrode and ground.

In the electrode, an arc discharge in hydrogen is maintained. This produces hydrogen atoms minus their planetary electrons and deuterons (double hydrogen atoms minus their electrons). The high voltage built up in the electrode propels the ions down a 40-foot-long vacuum tube into the material being studied. Directed at the targets at the bottom of the tube, the ions are accelerated en route by the electrical field created by the high voltage.

Since a mixture of several kinds of ions is produced, the beam is passed between the holes of an analyzing magnet. Here the lightweight ions are deflected more than the heavy ions, and the kind sought come out of one of the portholes in the analyzing chamber. Here the atom-smashing occurs.

The Van de Graaff machine is located in the Westinghouse East Pittsburgh Laboratory and was built in 1937. The 65-foot-high machine, used in the earliest uranium fission experiments, is now being reconditioned. Before the war, the Westinghouse machine was capable of imparting energies up to four million electron volts to accelerated particles at the moment of impact.

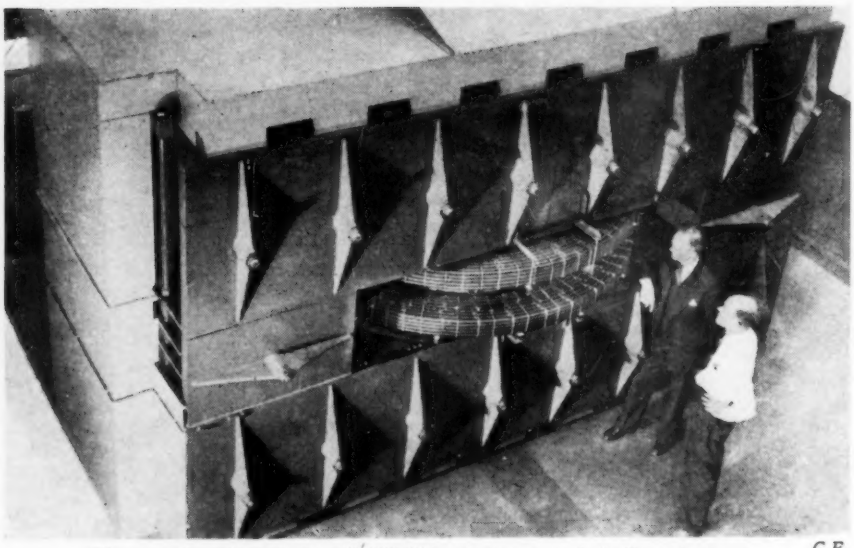
The important feature of the Van de Graaff machine is not the high voltage, however, but rather its steadiness. A series of plates, located at regular intervals along the length of the tube, carry the electrical field and cause all the "bullets" to move at the same speed at any one point in the path. Because of its ability to get from zero to four million volts with an accuracy of one-tenth of one per cent, studies of high precision can be made.

Another early atom smasher, which operates on a different principle than that of the Van de Graaff generator, is the cyclotron, invented in 1930 by Dr. E. O. Lawrence of the University of California. In this device, protons, deuterons, and other atomic "bullets" are accelerated to high velocities by sending them in an expanding spiral path and giving them a carefully timed pulse, or kick, twice each revolution. Cyclotrons, and the more recent accelerators, use a magnetic field to speed up the particles instead of the electrical field employed by the Van de Graaff machine. The cyclotron, although giving greater energy than the Van de Graaff generator, does not give as uniform a beam.

Energies up to ten million electron volts were obtained in prewar cyclotrons, and Dr. Lawrence had a giant

---

Mr. Shaw is the author of numerous articles on military and scientific topics.



The massive size of the 100,000,000-volt betatron is indicated above. *G.E.*

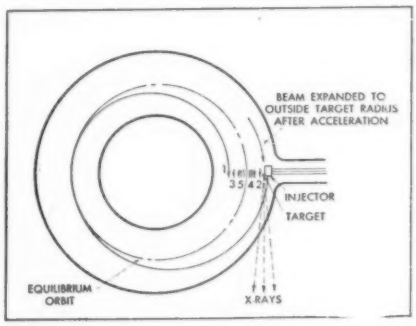
one under way early in the war. The huge magnet of this machine was converted to an "atom sorter" to separate uranium isotopes in the atomic-bomb project. The 225-ton cyclotron attains energies as high as two hundred million electron volts. This machine has the advantage of being able to handle particles of much larger size than the Van de Graaff generator.

Before the war, nuclei of carbon atoms were accelerated to ninety-six million electron volts on this machine. Bombardment with heavier particles results in atomic transformation—production of different elements—and production of radioactive elements. It can be readily understood why heavier particles do so much more damage.

The betatron, although operating on the same general principles as the cyclotron, accelerates only the lighter parts of the atom—the electrons. In this device, a pulse of electrons is turned loose inside a "doughnut" or ring-shaped glass tube supported between the poles of a large magnet.

THE betatron operates on principles similar to that of an alternating-current transformer. In the betatron, the secondary coil is replaced by the "doughnut"—essentially a vacuum tube. The electrons originate from a heated filament and, instead of traveling through a wire, flow in open space, held in their orbit by the huge electromagnet.

If the electrons remained in the tube continually, they would first revolve one way, then stop and reverse; but the trick is to get them out of the orbit while they are moving at maximum energy. As the current builds up in the first quarter cycle from zero to its maximum voltage in one two-hundred-fortieth of a second, the electrons make 250,000 turns and travel 800 miles. Then, before



Showing how the betatron works, this top view indicates how successive electron paths approach equilibrium at the center.

they go into reverse and lose energy, they are shifted from their orbit and made to hit a tungsten target, generating a beam of high-voltage X-rays.

For a full half cycle—from the time the current is at a maximum in the negative direction, while it is returning to zero, and building up in a positive direction—the voltage is positive and in the proper sense to speed the electrons. This offers the possibility of accelerating them nearly twice as fast as with the present method and consequently increasing their energy.

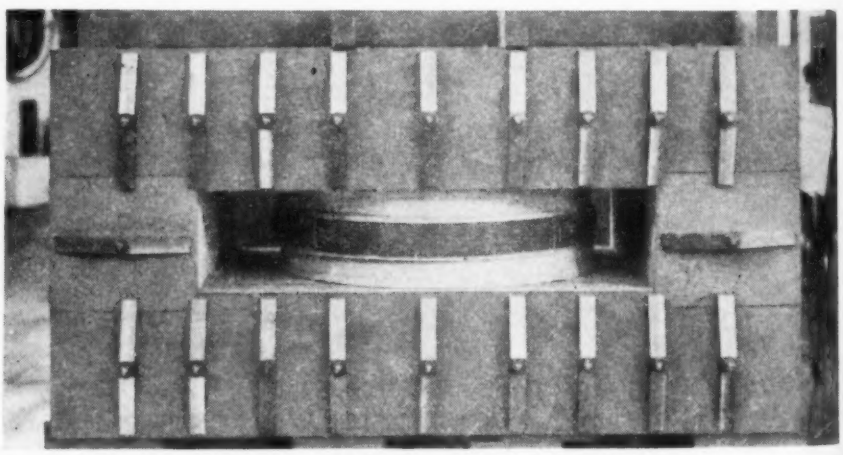
HOWEVER the difficulty is that while the voltage is passing from zero to its positive maximum, the magnetic field is in the wrong direction for guiding the electrons in their orbit.

The method devised at the General Electric laboratories for overcoming this difficulty is called the "D.C. bias." In addition to the alternating current, a direct current can be applied to the electromagnet. This shifts the zero line from the middle of the current wave to its bottom, and nearly the whole of the rise can be utilized.

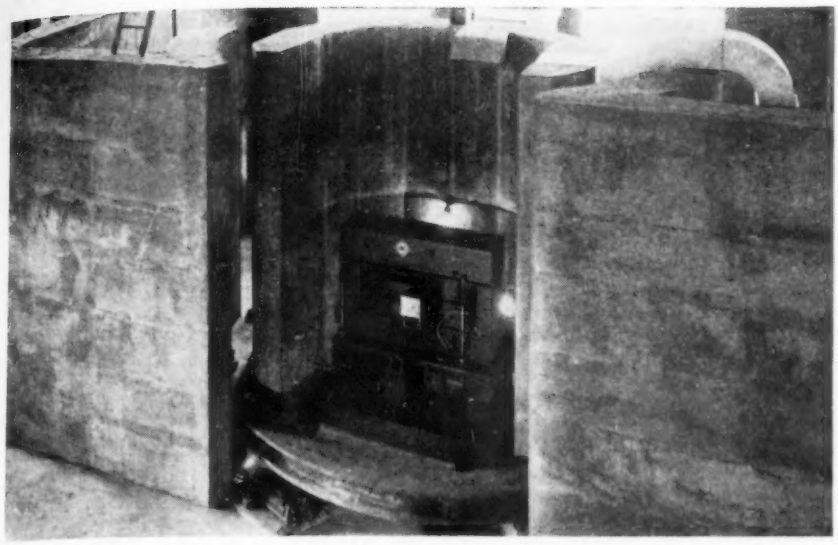
The General Electric Company, which has pioneered in this field, has been able to raise the output energy of its betatron from 100 million to 160 million electron volts by using this method.

A 20-million volt betatron unit, or X-ray machine, was recently built for the U.S. Army Ordnance Department by the Allis-Chalmers Company to be used in the examination of artillery shells and bombs. This betatron penetrates twelve inches of steel, revealing cavitation or other imperfections. This is the first production use of the betatron as an X-ray machine. An idea of its power can be gained when it is compared with an ordinary hospital machine rated at 85,000 volts.

The newest of the particle accelerators is the synchrotron. Invented independently by a Russian physicist and by Dr. E. M. McMillan of the University



The wooden model of the synchrotron above, served as a pattern for the real machine.



This 20,000,000-volt betatron at Picatinny Arsenal produces beams of X-rays that will disclose defects in loaded shells as they move around before it on the rotating carrier.

of California, construction of synchrotrons is now under way at the University of California and at the General Electric Research Laboratory in Schenectady, N. Y.

Essentially, the synchrotron is an application of the cyclotron to the betatron. In the cyclotron, particles enter a hollow, split-copper drum encased in a tank between poles of the magnet. Each time they go across the gap between the half-drums (known as "dees"), they receive a strong electrical push, the circle widening with each push until the particle emerges from a slit at the side. The time for particles to make the big circles is the same as for the small ones, the increasing speed exactly compensating for the greater distance traveled. The frequency of the alternating current which gives the particle its push is spaced so that the push always comes at the moment the particles are in the gap.

However, the theory of relativity predicts that particles will eventually become heavier as their energy is increased. The increased weight results in a tendency of the particles to lag and to arrive at the gap too late to be pushed. When the weight increase has become appreciable, the particles will tend to fall out of step with the regularly spaced electrical pushes and no further acceleration can be accomplished.

In the synchrotron, this effect will be overcome by changing the magnetic field to compensate for the slowing down of the particles as they become heavier. As the energy of the particle increases, the magnetic field of the synchrotron is increased, jerking the lagging projectiles up to the point where they will receive a push at the exact time the push is applied.

The synchrotron will borrow the cyclotron idea of repeated acceleration in a circular path. However, the characteristics of the particles it will accelerate—electrons—dictate the differences in detail of construction and operation.

BECAUSE it is so light, the increase in mass as the electron gains energy is proportionately huge, and this gain appears at relatively low energies. At 300 million electron volts' energy an electron weighs 600 times as much as it does at rest.

One result of the rapid increase in weight of the electron is that its orbit does not increase with energy but tends to remain in a perfectly circular path. Therefore, the synchrotron-accelerating tank will be doughnut-shaped. Instead of two half drums, or "dees," there will be one C-shaped "dee" inside the tank.

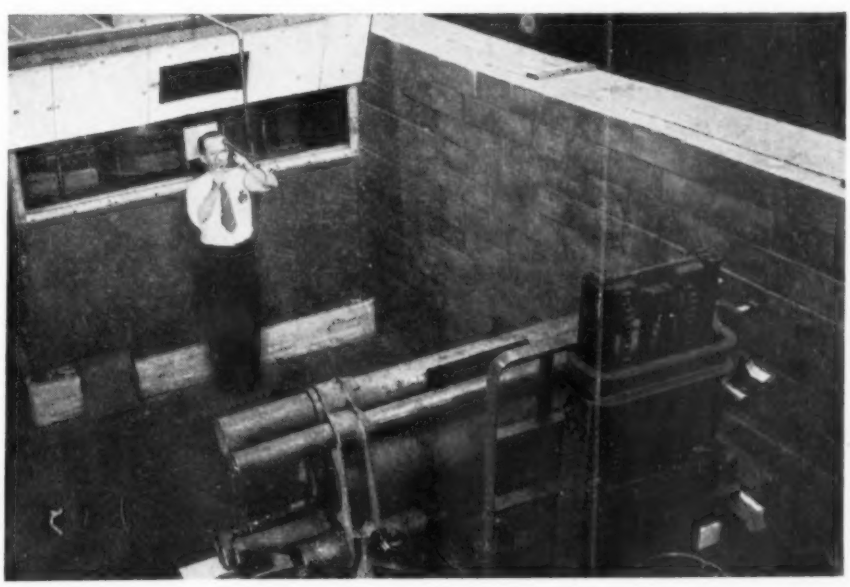
There is no limit to the number of times the electrons can be accelerated, but there is a limitation on the ultimate energy attained, imposed by the strength of the magnetic field.

In the synchrotron now being built at the University of California this limitation will become effective at 300 million electron volts. The doughnut-shaped magnet, to be made of laminated transformer steel, will weigh 135 tons. Its maximum field strength will be 10,000 gauss. The orbit in the acceleration tank between the poles will be one meter. The machine will be hollow inside.

The machine will operate as a betatron up to two million electron volts, at which point it will begin to operate as a synchrotron. At 300 million electron volts the particles accelerated will have traveled around the circular pathway 200,000 times before emerging in a beam.

The synchrotron is designed for a different atom-smashing job than the cyclotron. With 300-million-volt electrons, atom-smashing will mount a new threshold. It may be possible, instead of splitting the nucleus, to split the particles of the nucleus such as protons and neutrons.

With particles of these energies it will be possible to study the cosmic ray, for such a particle will produce cosmic-ray showers, such as occur in nature, of equal energy.



Preparing to inspect a recoil mechanism with the betatron at Rock Island Arsenal.

High-Speed Ordnance Transporters

Trucks That Can Carry Heavy Loads Through Combat Areas

E. R. Sternberg

The author is director of engineering of the Sterling Motor Truck Company, Milwaukee, Wis.

THE rapid change in the technique of modern warfare has emphasized the need for modern trucks capable of moving heavy loads at high speeds under varying conditions.

In the development of this automotive equipment it is first necessary to review the functional requirements of such vehicles and to weigh their relative importance. The loads to be hauled and whether or not the vehicle is to be used with a semitrailer or full trailer is one of many important factors to consider. Special attention must also be given to the possibility of using the same vehicle to fill more than one particular requirement; that is, one basic vehicle may be able to meet the requirement for a cargo truck, prime mover, wrecker, and tractor-truck.

A second factor of extreme importance is the matter of performance. Army vehicles are used in many types of operations and must negotiate all kinds of terrain. Such vehicles must be capable of a relatively high maximum speed, a reasonably high cruising speed and yet, at the same time, must provide a sufficiently low reduction to be able to operate at extremely low speeds for maneuvering into position and also to provide sufficient ability to negotiate the steepest and roughest grades.

The all-wheel-drive feature is a requisite to provide maximum traction. The use of the front-axle declutch enables the vehicle to operate on the highway at high speeds without resulting in gear fight and excess tire wear and yet permits engagement of the front driving axle to provide maximum tractive ability under the more severe operating conditions.

BECAUSE of the fluidity of modern warfare, the operating range of Army vehicles is now a more important factor than ever. Such vehicles must be capable of traveling long distances without refueling. The minimum wheel base and over-all length consistent with good load distribution must be furnished. The steering system must be designed to provide extreme ease of handling and the shortest practicable turning radius for maximum maneuverability.

Since Army vehicles usually travel in convoys, it is necessary for the basic design of all Army vehicles to be on a reasonably similar basis. All vehicles, regardless of size, should have approximately the same horsepower-to-weight ratio in order that all vehicles in a convoy may travel at approximately the same speed not only on level roads where horsepower requirements are relatively small but also on grades.

Maximum interchangeability of parts between vehicles is a further requisite. During World War II the volume of spare parts required to service Army vehicles was tremendous. It is evident that spare-parts requirements under similar conditions would be just as heavy. Therefore, any step taken toward reducing the total number of individual spare-parts items which must be considered would be very beneficial to the over-all operation of Army vehicles.

Giving each of these factors their proper weight in the design of an Army vehicle presents many complications with the result that this type of engineering must go far beyond that required to meet normal commercial requirements. Commercial vehicles are usually designed for certain specific functions which are determined prior to the design of the vehicle.

In many instances, the loads to be hauled are far in excess of those carried in normal commercial service. While the loads in some instances are no greater than those hauled in commercial service on combinations of truck-tractors and low-bed semitrailers, the speed requirements for Army use in hauling these same loads are much greater.

For example, 50- to 75-ton pay loads in commercial service are usually hauled at speeds of from 10 to 15 miles an hour whereas these same loads in Army service must be hauled at speeds up to 40 miles an hour.

The heavy transporters now being developed have been designed to meet these functional requirements. A number of these vehicles have already been delivered, while additional units are in the design stage.

Many problems had to be solved in order to produce the special chassis for these vehicles.

This is the first pilot model of the 12-ton 8x8 T26 equipped with a cargo body.

Due to the very high horsepower-to-weight ratio required, internal-combustion engines commercially available were not suitable for use in these vehicles because of their extremely heavy weight and large size in the horsepower ranges needed. Engines developing between 300 to 500 horsepower have already been installed in these vehicles.

In order to provide the horsepower required without excessive bulk and weight, the engines used were of the high-speed type. Higher horsepower engines will be installed in some of the later pilot models.

Because of the high torque loads and the high speed of the drive lines, in many instances commercial components were not suitable. To produce these vehicles, the development of many new components in addition to engines was necessary. New front and rear axles, transfer cases, brakes, propeller shafts, wheels, etc., were required. Heavier frames, springs, and new winches also had to be designed.

In all instances the largest feasible tire size was installed. Often sufficiently large tires were not available, with the result that it was necessary for the Ordnance Department to work with the tire manufacturer in developing and testing larger tires. For example, the 25-ton, 6x6 truck T46 is equipped with 18.00-29 tires which are nearly 70 inches in diameter.

One of the interesting phases of the heavy transporter development was the adaptation of the medium-tank engine to truck use. This engine was selected by the Ordnance Department for vehicles such as the 20-ton, 6x6 truck T29 and the 25-ton, 6x6 T46 because the engine developed approximately 500 horsepower and at the same time was relatively small in size and extremely light in weight.

The major development work involved in adapting this engine to truck use was that required for the two accessory drive units. The engine is equipped with two power take-offs located near the front. Because of the high horsepower output of the engine, two large fans were required. The design of the vehicles using this engine made it necessary also to provide drives for two air compressors, a large-capacity generator, and the hydraulic steering pump.

One of the largest vehicles delivered to the Ordnance Department is the truck-tractor T46. This truck was intended primarily as a tractor with heavy trailers to haul pay loads up to one hundred tons at forty miles an hour.

The 25-ton 6x6 T46 is used primarily as a tractor truck, towing up to 100 tons.

It is difficult to realize the actual size of this vehicle because the truck is so much bigger than any other motor truck previously produced. The chassis weight alone is approximately 60,000 pounds. The fifth-wheel load is 90,000 pounds, with the result that the gross vehicle weight carried on the truck tires (neglecting the weight carried on the semitrailer tires) is approximately 150,000 pounds.

THE T46 is one of the vehicles equipped with the medium tank engine. Power is transmitted from the engine through the clutch to a propeller shaft and then to the main transmission which provides a total of ten forward and two reverse speeds. From the main transmission the power flow is through another propeller shaft to the 2-speed transfer case where the power is divided to the front axle and to the jackshaft unit.

The drive from the transfer case to the front axle passes through a compensator box which is required to match front and rear axle ratios. The front axle is of the double-reduction type fitted with constant-velocity joints.

The jackshaft unit is equipped with three supertraction differentials which divide the power equally to each of the four rear driving wheels and yet, because of their special design, reduce the amount of wheel spinning normally encountered with three differentials. Final drive from the jackshaft unit to the rear wheels is by means of chains and sprockets.

Another interesting vehicle in the Ordnance heavy transporter program is the 12 ton, 8x8 truck T26. This vehicle has eight driving wheels equipped with either single or dual tires and thus provides unusual flotation and tractive ability. In this vehicle the conventional front driving axle is replaced with a bogie unit similar to the rear bogie.

The entire front bogie steers as a unit similar to a standard 4-wheel trailer except that it is necessary to transmit power through the jackshaft unit by means of a right-angle drive incorporated therein.

These advantages as well as others were definitely proved in tests made at Normoyle Field, San Antonio, Tex. Operating in a specially prepared mud pit and equipped with tandem traction devices on all wheels, the ability of the vehicle to maneuver was unsurpassed. When operating in this mud pit it was possible to steer the front bogie and have the vehicle travel in the desired direction.

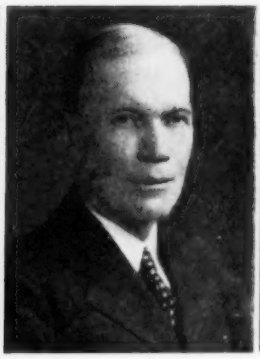
The 8x8 construction also provided several additional advantages of unusual importance. Because of the fact that it was possible to equip both front and rear bogies with dual tires, maximum tractive ability and flotation is provided. This construction permitted this vehicle to operate in mud fifty-three inches deep and complete the run through the mud pit.

Another advantage is that the bogie construction at the front as well as the rear permitted the vehicle to climb 42-inch concrete walls carrying pay loads as high as 15 tons resulting in gross vehicle weights in excess of 85,000 pounds.

Many new developments are pending in the commercial truck field. It is evident that many of these future developments will need to be adapted to military use. Such development work must be continued to assure that the most modern equipment will be available to our armed forces.

For Eminent Service We Salute—

Maj. D. B. MacMaster



Col. A. H. Pugh

Col. W. E. Becker

A. J. Mummert

A. F. MacConochie

Maj. Don B. MacMaster, public relations counsel, New York City, served with distinction in the New York Ordnance District during World War II. Long a member of the New York National Guard, he is aiding the Ordnance fraternity in a special way through the Public Relations Committee, A.O.A.

Col. A. H. Pugh, president, A. H. Pugh Printing Company, Cincinnati, throughout World Wars I and II contributed splendid leadership to the Ordnance cause. In addition to his services to the Cincinnati District he helped organize the Cincinnati Post, A.O.A., and has served as one of its officials since 1925.

Col. Ward E. Becker, Ordnance officer of the Regular Army, is director of development and proof services of the great Aberdeen Proving Ground. During World War II he held Ordnance assignments of first importance in the North African campaigns from Casablanca to Bizerte and with the Eighth Army in the Pacific from Australia to Yokohama.

A. J. Mummert, executive vice-president, McQuay-Norris Manufacturing Company, St. Louis, Mo., is a member of the executive board of the Association's Small Arms and Small Arms Ammunition Division. He helped marshal the forces of his company in the phenomenal production of armor-piercing cores in World War II. He is a leader in the field of mass production of automotive and aëronautical equipment.

Prof. A. F. MacConochie, professor of mechanical engineering at the University of Virginia, did outstanding work for Ordnance in World War II, first in shell-forging research and production engineering of artillery ammunition and later in the preparation of mechanical data on all types of modern ordnance equipment.

Col. Louis Johnson, former Assistant Secretary of War, deserves all praise for his dynamic leadership of industrial mobilization from 1937 to 1940. Due to his energy and leadership American science and industry were mobilized when World War II became imminent. At the time of Pearl Harbor, a firm groundwork had been laid for gigantic ordnance production—thanks to his energy and skill.

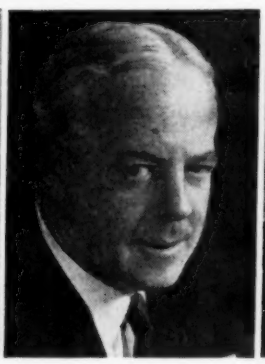
Hiland G. Batcheller, president of Allegheny Ludlum Steel Corporation, Pittsburgh, did outstanding work for victory in World War II as director of the steel division, War Production Board, and later as vice-chairman in charge of operations. A leader in the steel industry, he has served the Army and Navy Munitions Board and the Army Ordnance Association with distinction.

Col. Elmer C. Goebert, now on the engineering staff of Duplex Printing Press Company, Battle Creek, Mich., is unexcelled in the records of ordnance design, development, and production. He culminated a long career as an Ordnance officer of the Regular Army at Rock Island Arsenal during World War II and was largely responsible for the stellar record of that great establishment in the production of ordnance and in cooperation with American industry.

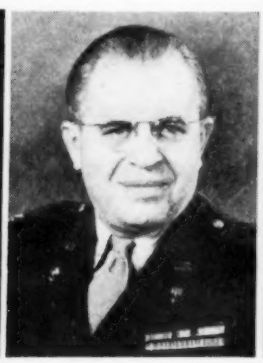
Sanford L. Cluett, inventor, engineer, and industrialist, is vice-president of Cluett, Peabody & Company, Troy, N. Y. He is an inventor of note and holds more than 170 patents for the mechanical shrinking of textile fabrics. Neighbor to Watervliet Arsenal, he gives unsparingly of his time and talents for the advancement of scientific and industrial preparedness as a guarantee of peace.

Rudolph Furrer, vice-president of A. O. Smith Corporation, Milwaukee, con-

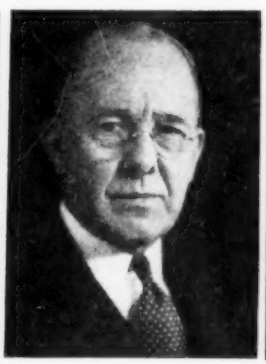
Col. Louis Johnson



H. G. Batcheller



Col. E. C. Goebert



S. L. Cluett

Rudolph Furrer

These Industry-Ordnance Leaders

Prof. O. W. Boston

William Steinwedell

Lieut. Col. F. R. Mead

Walter Geist

H. A. Roemer

tributed notably to the success of bomb-production progress in World War II. Chief engineer of an organization famed for the development of mass-production methods with cold-worked metals, he served as a member of the War Metallurgy Committee and was a special consultant in Ordnance research and development. He is an active member of the A.O.A. Rocket, Bomb, and Artillery Ammunition Division.

Prof. Orlan W. Boston is professor of metal processing and chairman of the department of metal processing, College of Engineering, University of Michigan. He is also custodian of the Ordnance Gage Library at the university. In World War II he directed the training courses in ordnance and aircraft inspection and engineering aids at the university.

William Steinwedell, well-known official of Stewart-Warner Corporation, Chicago, rendered outstanding service to the Ordnance cause as general manager of the Green River Ordnance Plant, Dixon, Ill., throughout World War II. He is an active member of the Artillery Ammunition Committee, A.O.A.

Lieut. Col. Frank R. Mead rendered outstanding service in World War II in the New York Ordnance District, first as chief of artillery, tank, and automotive vehicles and later as officer in charge of the Montreal and Ottawa Regional Ordnance Offices. He administered all War Department Lend-Lease contracts in Canada.

Walter Geist, president, Allis-Chalmers Manufacturing Company, Milwaukee, directed the vast military and naval production progress of that organization throughout World War II. Recognized as a leader in mechanical and human engineering, he is a director of the Milwaukee Post, A.O.A.

H. A. Roemer is chairman and president of Sharon Steel Corporation—a leading contributor to Ordnance success in World War II. He is also chairman of Mullins Manufacturing Corporation, Salem, Ohio, likewise a notable factor in the production of wartime ordnance.

Robert H. Startzell is sales manager, Sheffield Steel Corporation, Houston, Tex. He is also president of the Texas Post, A.O.A. In both capacities he has taken a leading part in the advancement of Ordnance in the Lone Star State.

Norman K. Haig is director of Government sales, General Motors Corporation, Detroit. During World War II he was with and for a time directed the General Motors War Products Training Service. Long identified with GM, he has made valuable contributions to Army and Navy Ordnance.

Lieut. Col. Fred D. Hansen, president, Milwaukee Post, A.O.A., rendered outstanding service to the national defense as head of the Milwaukee Ordnance Office in World War II. He has the respect and admiration of all Ordnancemen.

Col. J. O. Johnson of Gordonsville, Va., is as responsible as any one man for the fact that there were no ordnance gage problems in World War II. He directed ordnance gage activities as chief of the Gage Section during a great part of the period between the World Wars. Thanks to his energy, ability, and knowledge of gages, American industry was able to undertake ordnance gage production long before Pearl Harbor.

Col. Boone Gross is general manager, Gillette Safety Razor Company, Boston, Mass. First as commanding officer of the Eau Claire Ordnance Plant and later as chief of the Philadelphia Suboffice for small-arms ammunition production, at war's end he was chief of the Storage Division, Office of the Chief of Ordnance—Detroit.

R. H. Startzell

N. K. Haig

Lieut. Col. F. D. Hansen

Col. J. O. Johnson

Col. Boone Gross

"Little David"

American Industry Built the Biggest Mortar in the World

Col. Clyde H. Morgan

AS WINTER turned into spring in early 1944, plans were rapidly nearing completion for the invasion of Nazi Europe. Every contingency had been provided for; every item of essential supply was on its way. Intelligence reports leaking out of the tortured continent indicated that the German High Command was hastily preparing several powerful switch lines of defense.

Defensive works based on experience gained in construction of the Siegfried Line were planned for the great river barriers of the Loire, Seine, and Marne, with offshoots to seal the bases of the great peninsulas jutting out into the Atlantic. These works consisted of partially buried, reënforced-concrete redoubts studded along the defensive lines at a frequency of twenty-five to the mile in the important sectors. Each echelon in the defense chain was to be some 50 feet long, 30 feet wide, and 17 feet high, with roofs and walls of reënforced-steel 7 feet thick.

Military prudence demands adequate plans to meet any eventuality. Should our invasion forces surging over the beachheads be halted, means must be provided to overcome the defense and maintain the tempo of the attack. Experience indicated that existing field-artillery weapons could not accomplish the task without excessive losses and at practically point-blank ranges. Thus a new solution was urgently required.

Early in March the Army Ground Forces expressed their grave concern and presented the problem to the Research and Development Service of the Ordnance Department. At a conference in Maj. Gen. G. M. Barnes' office on the eleventh day of March, the "Little David" project was initiated. Translating the problem in turn from the nature of the target to the projectile required to encompass its destruction and thence to the weapon, General Barnes logically bounded and defined the engineering problem.

It was calculated that the destruction of these German fortifications would require a weapon that could hurl a monstrous projectile weighing more than 3,200 pounds a distance of at least 7,500 yards. Firing from a protected position in defilade it would require such refined accuracy that a totally destructive hit would be registered on each redoubt in but one or two shots.

The weapon had to be readily transportable over existing highways, highly mobile and independent of rail movement. It had to be capable of being emplaced after darkness, fired by midnight, and withdrawn before daylight after its deadly mission had been accomplished. Initial deliveries were specified for six months from date of initiation of the project.

TO meet these specifications it was determined that a gigantic mortar of 36-inch bore would be required. The ammunition would bear a striking similarity to two bathtubs welded rim to rim. To ensure road mobility, two enormous tank transporters would be needed, one for the 38-foot rifled tube and the other for the base mount and recoil system.

It was obvious that to meet the specified delivery dates maximum use would have to be made of standardized components, but they were nonexistent except commercial motors, pumps, valves, electrical controls, and the sighting telescopes with their quadrants. All other parts required to handle this equipment, such as hydraulic jacks, supporting equipment, and dollies for transportation, had to be produced.

As a background of experience, Ordnance had been developing 6- and 10-inch mortars which in no sense presented comparable problems. Sketchy information was available on the huge German supercannons which represented the most colossal efforts of the Krupp domain (see ARMY ORDNANCE, November-December 1946, p. 254).

To make the record of "Little David"—gun and ammunition—complete, we will publish in the next issue the story of the ammunition. Just as Mr. Iversen and his coworkers wrought a miracle in building the mortar, so A. R. McAllister of Babcock and Wilcox Company, Akron, Ohio, led the loyal group in industry and Ordnance who won the battle of designing and making the ammunition. Mr. McAllister is now writing that saga. And, it goes without saying, Mr. Iversen and Mr. McAllister represent all those who worked like Trojans to build America's largest gun.—EDITOR.

During World War II, Colonel Morgan was an assistant to Maj. Gen. G. M. Barnes in the Ordnance Research and Development Service and later was chief of the St. Louis Ordnance District. He is vice-president of the St. Louis Post, A.O.A.

Even this data was of little value since the Nazi weapon was five inches smaller in caliber, required a train of twenty-five cars to move, and emplaced on parallel rail tracks, three weeks being needed to complete the installation.

Acting upon the advice and with the counsel of that eminent friend of Ordnance, Frank B. Bell, the gravity and difficulties of the problem were presented to Lorenz Iversen, president of the Mesta Machine Company. No wiser choice could have been made. Working in complete disregard of personal strain and as much as 16 to 18 hours a day, he had blocked out the basic design of the world's largest cannon by the time a contract was received on May 9, 1944.

Next followed a series of agonizing months while the basic designs were refined, detailed, and reduced to practice in actual construction. Each day brought fresh heartbreaks which dwarfed those of the day before. Lesser men would have given up the task as impossible. But each problem surmounted gave encouragement and brought the final solution nearer to view. Steadily, persistently, progress was made. It is not intended to recount the many difficulties encountered, but simple justice demands a record of the achievements attained.

Extraordinary security measures were taken during the design, manufacture, and test of "Little David." Mr. Iversen carried out all preliminary design and layout work with the aid of one draftsman in a special locked room. The project as a whole was designated Bomb Testing Device T1 in order to conceal the actual nature of the weapon.

As developed, the base of the 36-inch mortar was in the form of a steel box approximately eighteen feet long, eleven feet wide, and ten feet high. It was designed to be emplaced in a pit, using shell or bomb craters where convenient. The base was designed to contain elevating and traversing mechanisms and all control equipment, including a hydraulic pump and jacks for use in emplacement and removal of the base and for mounting the tube assembly.

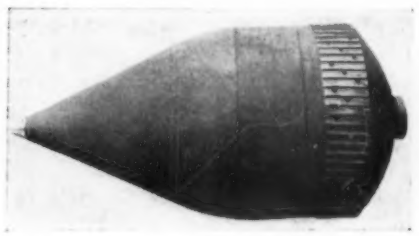
This latter unit consisted of the rifled muzzle-loading mortar tube of right-hand twist (one turn in sixty calibers), the elevation segment, and the recoil mechanism. Ammunition of various types was developed ranging from 3,200 to 3,650 pounds in weight and incorporating preëngraved rotating bands. The propellent charge consisted of a 136-pound base section and two zone increments each weighing forty-one pounds.

The original specifications for the mortar tube provided for a yield strength of 65,000 pounds per square inch. By employing a novel method of triple quench, Mesta was able to raise the yield point to 95,000 p.s.i. which was reflected in a range increase from the original 7,500 to 9,500 yards.

On October 9, 1944, just five months from the day the contract was received, the pilot model was completely assembled. Following plant tests, the units were transported overland by road to the Aberdeen Proving Ground. By numerous trips over the highways, the roadworthiness of the matériel was effectively demonstrated. The base unit of the pilot mortar was shipped on October 28th, arriving at Aberdeen the following day, and within thirty minutes it was emplaced in the pit. The tube was shipped two days later and was likewise installed in half an hour.

THE first test projectile was fired from "Little David" on October 31st. Preliminary projectile ballistic and design data had been obtained from firing special 155-mm. ammunition shaped like the mortar projectile and proportioned similarly as to weight. In order to accumulate range data for the firing tables, extensive and expensive firing would be required. Therefore, the 75-mm. howitzer M8, which had about the same exterior ballistics and a high rate of fire, was used for determination of preliminary data and served to place the mortar accurately on the target.

The destructive effects of "Little David" fully lived up to expectations. Immense, deep craters were formed

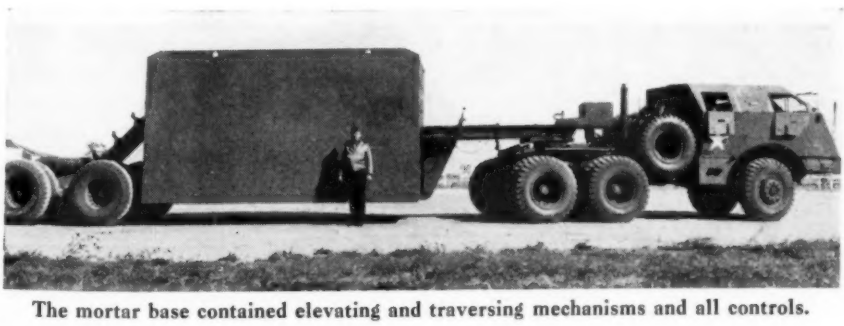


"Little David's" concrete-smashing projectiles weighed about 3,500 pounds.

which could fully accommodate a fair-sized apartment building. Its effect on the German type of redoubt was evaluated by static detonation which indicated complete crushing of the concrete slab over an area of some one hundred square feet. The concussion effect of adjacent detonations caused extensive damage so that a redoubt and personnel inside would have been permanently demobilized.

In the meantime the war in Europe was progressing at an accelerated pace. General Patton in his armored drive across France had destroyed the last German hope of a switch-line defense. The Siegfried Line had been breached at Aachen. The termination of hostilities in Europe only awaited the transport of needed matériel to the front and the arrival of good weather. The misguided German offensive of the Bulge in December merely served to deplete the enemy's reserves and hasten the end. Accordingly, the help of "Little David" was not required in the European theater, and the project was reoriented toward Japan.

On Okinawa, progress was proving slow and costly where the Nips were dug in along Shiri Ridge. This looked like an ugly portent of things to come when the final invasion of the Japanese mainland would begin. Again a weapon was needed that could blast out the foe from as deep as he could dig, and plans were made to ship the mighty mortar and trained personnel to assist in the coming attack. Then came a holocaust from the sky! The atomic bomb had settled the issue, and peace was won. Though never destined to fire a shot in battle, "Little David" remains an epic of American industrial might—the largest cannon in the world.



The mortar base contained elevating and traversing mechanisms and all controls.

Small Arms for Security

The Industry-Ordnance Team Carries On

C. K. Davis

THE lessons of two World Wars have highly emphasized the importance of "know-how" in the manufacture of arms, ammunition, and all war equipment needed by our armed forces in a national emergency.

Just prior to World War I, on June 3, 1916, Congress adopted our first National Defense Act.

Section 121 of that act directed that a board be appointed to study the question of whether the armament for our armed forces should be made in time of peace in our government arsenals or by private industry—one or the other or both.

The board, later known as the Kernan Board, was well qualified for its task. It consisted of Col. Francis J. Kernan (later Major General, who organized the Service of Supply, A.E.F., November 1917–July 1918), Lieut. Col. Charles P. Summerall (later General, commander of the 1st Division and of the V, IX, and IV, Army Corps, A.E.F., in World War I and Chief of Staff, U.S. Army 1926–1930), Benedict Crowell (later the Assistant Secretary of War and Director of Munitions in World War II, president of the Army Ordnance Association 1919–1944), and Robert Goodwyn Rhett (then president of the United States Chamber of Commerce).

The Kernan Board reported its findings after exhaustive study. One appropriate portion of the findings of this Board is of special interest at this time: "No feature of the board's experience is more impressive than the attitude of private manufacturers to this whole question of preparedness. It is clear that the enormous difficulties they themselves have experienced in arriving at successful production, combined with the extraordinary size of the foreign demand, has made such a lasting impression that the carrying on of modern war is a task of stupendous magnitude and of extreme difficulty from every angle. They are more than willing to coöperate; they are anxious to do so, fully realizing that in successful coöperation with the Government lies the best if not the only certain chance of success.

"Apprehension has been expressed that Government contracts and a potential capacity to turn out war material might foster the growth of a class whose profitable interests would lie in war, and who, in consequence, might in time become a danger to the State. It is not the belief of this board that any such danger exists in our country.

"The number of plants and of persons concerned when considered in reference to the whole country; the total of industrial plants and of people, is relatively too insignificant. We know the function of the leaven in respect to the mass; but we know, too, that the mass must be adapted to the particular leaven if anticipated results are to follow, and it is impossible to believe that we constitute a mass responsive to a leaven and warlike provocation and ready to belie our strongest characteristics by taking on, under the workings of an insidious few, the nature of a war-seeking people . . .

"On the other hand, we cannot fail to realize that the danger of a national catastrophe through a lost war is a real danger which we have to provide against, and only through such coöperation with private industry can it be practically done."

Perhaps the present Under Secretary of War, the Hon. Kenneth C. Royall, was motivated thirty years later by similar thinking as that expressed above when he requested the advice of representatives of American industry in determining a policy to govern the placing of production orders for small-arms ammunition with industrial concerns in time of peace. His request was transmitted to the Chief of Ordnance, Maj. Gen. Everett S. Hughes, and thence to the Army Ordnance Association in the form of a question phrased as follows:

"During time of peace, should the Ordnance Department continue to place mass-production orders for standard types of small-arms ammunition at Government arsenals or should such orders be placed with commercial companies to the exclusion of Government establishments?"

On November 4, 1946, the executive vice-president of the Army Ordnance Association, Leo. A. Codd, wrote to the secretary of the Association's Small Arms and Small Arms Ammunition Committee, Wallace L. Clay, saying that the Ordnance Department of the Army desired counsel and advice with respect to the policies which should be adopted by the Department to apply in time of peace regarding the mass production of small-arms ammunition as between governmental arsenals and private industry. This committee has been formed out of our experience in two World Wars. That experience convinces us that inasmuch as industry must play an essential rôle in war, its coöperation in time of peace is indispensable in planning for the future safety of our country.

A meeting was held on December 3, 1946, in the conference room of the Chief of Ordnance for a discussion of this important matter. Our Industry Committee was fully represented by the respective members or alternates designated by them. The Chief of Ordnance with a number of his staff and members of the Under Secretary's office and the General Staff were present representing the War Department. In addition, prominent members of the Army Ordnance Association attended.

At the conclusion of this meeting a subcommittee consisting of J. M. Olin, president of Olin Industries, Inc.; A. J. Mummert, executive vice-president of the McQuay-Norris Manufacturing Company; and our secretary, Wallace L. Clay, were appointed to reduce to writing the views of the industry on the question propounded. The subcommittee members and the writer met with representatives of the War Department on February 7, 1947, for a discussion of additional phases of preparedness measures which had not been considered at the meeting on December

Colonel Davis is president of the Remington Arms Company and chairman of the Army Ordnance Association's Small Arms and Small Arms Ammunition Division.

3, 1946. At the end of this conference the conclusions reached by representatives of our industry were summarized in a letter to the executive vice-president of the Association which in turn was transmitted to the Chief of Ordnance. Our letter, dated February 10, 1947, follows:

"IN a letter dated November 1, 1946, Brig. Gen. J. L. Holman, Chief of the Industrial Service, Ordnance Department, Washington, D. C., advised you that a question of policy had been raised at a meeting in the War Department, October 29, 1946, relating to the future procurement of small-arms ammunition. The letter sets forth that the Under Secretary of War, the Hon. Kenneth C. Royall, stated that he would like to have the advice of representatives of industry in determining a policy to govern the placing of production orders for this type of ammunition with industrial concerns. In turn the Director of Service, Supply, and Procurement, Lieut. Gen. Le Roy Lutes, requested the Chief of Ordnance to submit this question to the proper members of the small-arms ammunition industry to obtain the benefit of their opinions on this matter. General Holman stated in his letter to you that the question to be presented might well be phrased as follows:

"'During time of peace, should the Ordnance Department continue to place mass-production orders for standard types of small-arms ammunition at Government arsenals or should such orders be placed with commercial companies to the exclusion of Government establishments?'

"In response to your letter of November 4, 1946, on this subject, a meeting of the executive committee of the Small Arms and Small Arms Ammunition Division of the Army Ordnance Association was held at the Pentagon Building, Washington, D. C., on December 3, 1946, at which time General Holman's question was discussed by representatives of the War Department and the small-arms ammunition industry.

"The conclusions reached by representatives of the industry can be summarized as follows:

"1. Permanent Government arsenals should participate in the production of peacetime requirements for small-arms military ammunition. Operation of a pilot production line by the arsenal will permit continued accumulation of detailed technical information covering all phases of ammunition production under conditions simulating those of mass production. For example, a production schedule of approximately 50,000 caliber .30 M2 cartridges per day will require continuous one-shift operation of the more important machines in the pilot line. New or improved materials, machines, tools, and techniques can be proofed by extensive use at the arsenal.

"2. If and when the peacetime requirements for small-arms military ammunition exceed the pilot-line capacity of the arsenal, the remaining requirements should be produced on other pilot lines similar to that of the arsenal, installed in commercial plants of those organizations comprising the small-arms ammunition industry of the United States which will be expected to expand to full-scale mass production should the need arise. If and when requirements for small-arms military ammunition exceed the pilot-line capacity of the arsenal and the commercial plants, the Government should negotiate with commercial producers of ammunition for the activation of additional production in appropriate plants.

"3. Government arsenals are recognized as the logical facilities through which development and research on new and improved types of military ammunition should be coördinated. However, the research facilities of industry should augment and complement those of the arsenal, and the accepted results of such research should be reviewed jointly by industry and the arsenals before the details of mass production are reduced to a firm specification. The flow of information between Government arsenals and the industry on research and development subjects, as well as on production technique, should be bilateral and continuous The advantage to both parties is obvious.

"It is the opinion of the industry, based on experience gained during the last two wars, that national security, as related to availability of trained personnel, military as well as civilian, and suitable facilities translated to potential productive capacity for small-arms military ammunition, is best served by adoption of the procedures outlined in the foregoing. These procedures will permit training of the greatest number of personnel and, should the occasion arise, will permit expansion of productive lines at the maximum possible rate.

"We believe, as do you, that *time* will be the all-important factor should we again be engaged in war. Industry will be best prepared for such an emergency if permitted to coöperate fully with the War Department in peacetime development and production of military requirements."

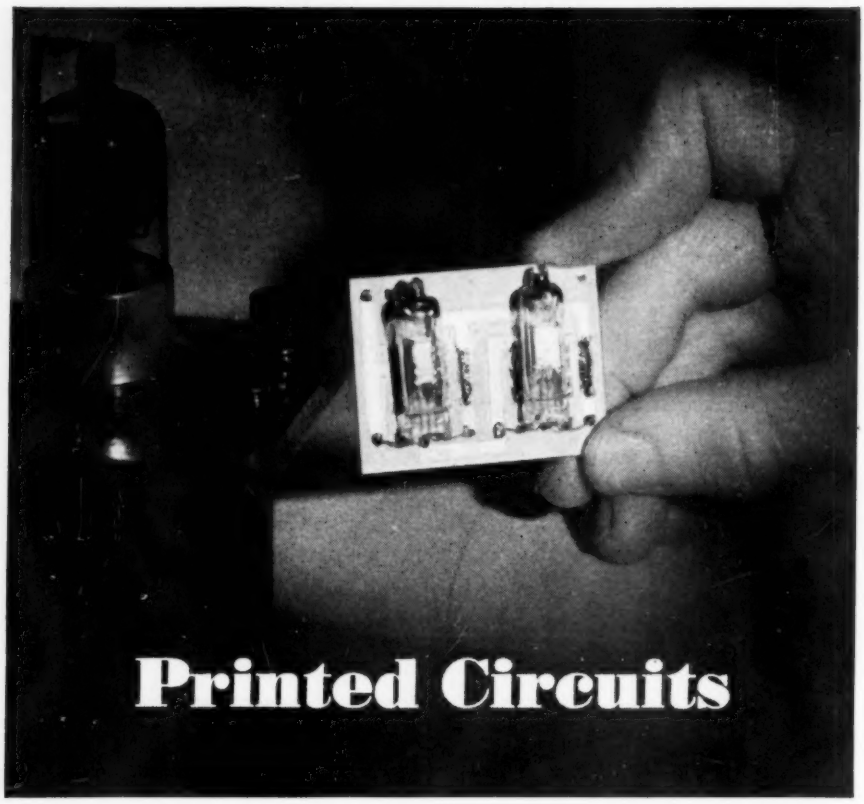
With the advent of the atomic bomb, guided missiles and numerous other electronic devices, we can foresee an agressor attacking our cities, plants, and communication systems with an array of missiles, producing a kaleidoscopic effect which may make our defense impotent at the very start unless we are completely prepared to cope with such a situation.

In considering the future, one other fact must be remembered. A review of all major conflicts, including World War II, discloses that trained ground troops, whether on foot or transported by motor vehicles or aircraft, are the means of bringing about the eventual surrender of the enemy.

This connotes that the individual soldier's equipment, the armament for motor vehicles and aircraft required to transport supplies and new weapons, together with the large requirements of the Navy and Marine Corps for small arms and small-arms ammunition will again prove to be the most important items for mass production in another emergency.

SMALL ARMS AND SMALL-ARMS AMMUNITION DIVISION COMMITTEE, A.O.A.

C. K. Davis, Remington Arms Company, Bridgeport, Conn., *Chairman;* Graham H. Anthony, Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn.; Ward M. Canaday, Willys-Overland Motors, Inc., Toledo, Ohio; Wallace L. Clay, Remington Arms Company, Bridgeport, Conn.; C. Stewart Comeaux, Sporting Arms & Ammunition Manfacturers' Institute, New York, N. Y.; Arthur G. Drefs, McQuay-Norris Manufacturing Company, St. Louis, Mo.; C. Donald Dallas, Revere Copper and Brass, Inc., New York, N. Y.; F. F. Hickey, Savage Arms Corporation, Utica, N. Y.; O. E. Hunt, GMC, Detroit, Mich.; John M. Olin, Olin Industries, Inc., East Alton, Ill.; P. D. Wagoner, Underwood-Elliott-Fisher Company, New York, N. Y.; T. J. Watson, International Business Machines Corporation, New York, N. Y.



Printed Circuits

A War-Developed Process Promises To Revolutionize Electronic Design

Complicated wiring and units of miniature radio sets can now be easily produced in quantity

by
Cledo Brunetti
and
Philip J. Franklin

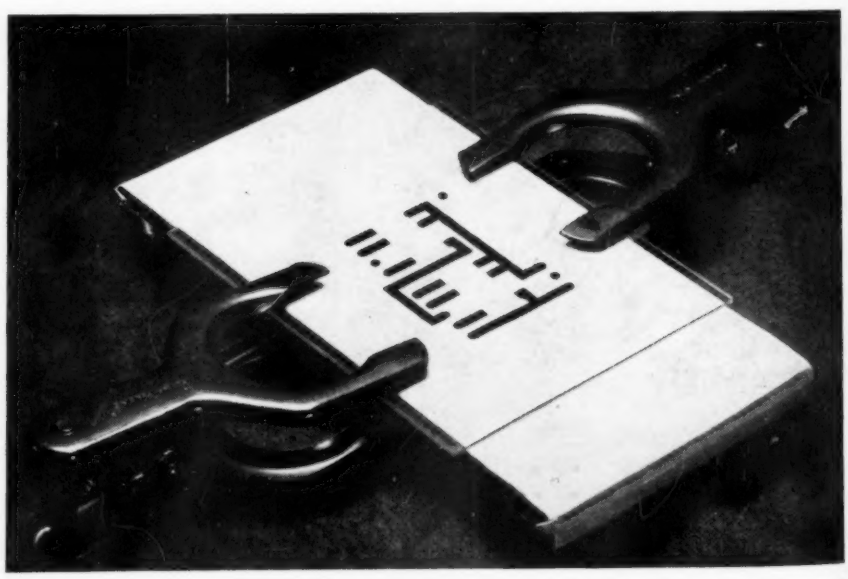
THE printed electronic circuit, a method of printing wiring and circuit components on an insulated surface, is an important new process and technique evolved from research and development during the war. The new technique, developed by the National Bureau of Standards in coöperation with electronic manufacturers for the tiny generator-powered radio proximity fuze, promises to simplify production methods and to accelerate the manufacture of cheaper, more compact, and more uniform electronic equipment.

The methods of manufacture are applicable in the design of numerous industrial and commercial devices where extreme ruggedness and small size are imperative. By means of the printing process the electronic circuit of a conventional radio—now characterized by a maze of wires, resistors, inductors, and condensers—may be replaced by a compact circuit printed on a small flat plate, eliminating much of the third dimension and making it simple to check and repair.

OTHER specific applications lie in the fields of pocket radios, personal radio telephones, miniature hearing aids, meteorological instruments, and various miniature electronic control circuits.

Present investigations at the National Bureau of Standards of the various means available for reducing the size of electronic assemblies and for mechanization of chassis wiring reveal a number of feasible and practical electronic printing methods. Variations of the stenciled-screen process include hand printing or spraying of the components and leads on suitable surfaces. Another method involves the use of photography and an abrasive blast. A third is an adaptation of the chemical methods of silvering mirrors.

Mechanical processes include metal spraying, metal sputtering or evaporation, the use of foils, and stamping. As an example, loop antennas are now stamped out in a single operation by a variation of the printed-wiring techniques and have shown improved performance over wire-wound loops in addition to reduced cost of production.



The stencil is being prepared photographically by exposing a sensitized silk or metal screen through a glass negative, thus fixing the parts of the screen subject to light.

The principal effect of these methods is to reduce electronic circuit wiring to two dimensions. The effect is enhanced where it is possible to employ subminiature tubes and compact associated components.

Four simple techniques are the key to the electronic printing process which led to the design of control circuits capable of meeting the space limitation and ruggedness requirements of the VT fuze. First, the circuit wiring and inductors are painted or stenciled with silver paint on a chassis or base material, such as a plate of steatite. Secondly, the resistors, in the form of a carbon and resin mixture, are stenciled or sprayed on the plate through masks that locate them accurately between designated end tabs.

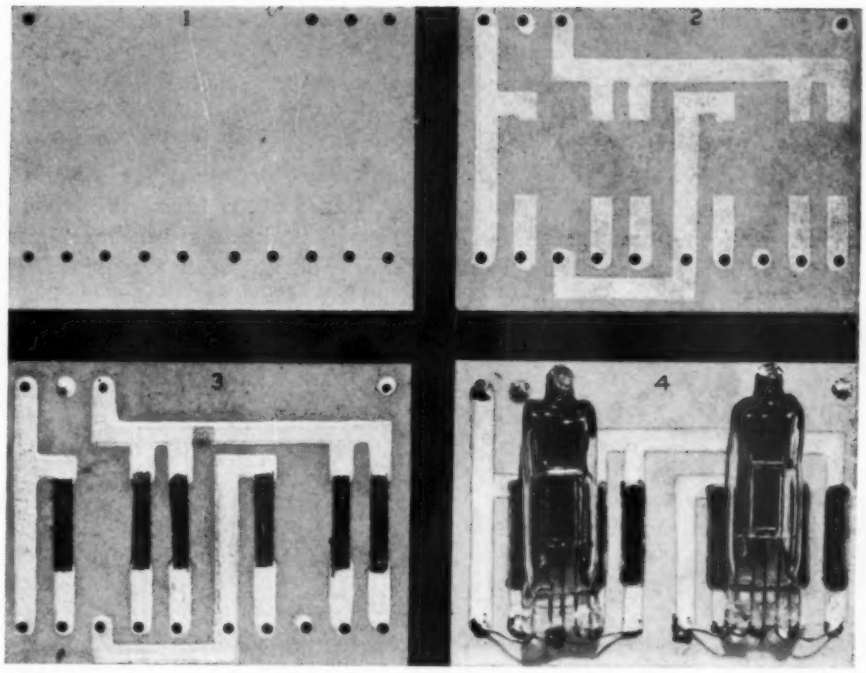
The small disk-type capacitors, of high dielectric ceramic, are then applied directly to the wiring on the plate. Lastly, other components, such as tubes, are fitted into properly located holes in the ceramic and soldered in place. In this manner a compact electronic circuit assembly, readily adaptable to high production techniques, is obtained.

Any insulating surface may be employed as a base plate for the wiring. Thus, electronic circuits may be printed on glass, porcelain, plastics, cloth, paper, and any other material having suitable insulating properties. Steatite, a hard and dense ceramic material, is well adapted for use as a base.

In fabricating, carefully selected ground talc and small percentages of clays, fluxes, and organic binders are worked with the addition of water into a uniformly plastic condition. The mixture is then molded into plates under pressures between five and ten tons per square inch. The plates are dipped into glass-forming materials and fired in kilns at a temperature of about 2,400 degrees Fahrenheit, producing a hardness approaching that of sapphire. The resulting material, steatite, is unaffected by water, solvents, or even acids—important factors in its electrical use.

The next step in printing the circuit is to apply a pattern of silver lines to the ceramic, either directly with a brush or by using a silk or metal stencil.

The stencil is produced by coating silk or metal screens with a substance such as gelatin or polyvinyl alcohol which is made photo-sensitive by treating with potassium dichromate. A sheet of paper bearing the desired wiring pattern is held tightly against the screen and exposed to strong light. Exposure "fixes" the chemicals on the screen except for those portions beneath the wiring diagram.



Steps in making printed electronic circuits: 1, the steatite plate; 2, the printed wiring; 3, with painted or stenciled resistors added; 4, the unit assembled with tubes.

THE silk or metal is then washed in water, and those parts not exposed to light dissolve in the water and wash out, leaving openings in the screen corresponding to the desired wiring diagram.

The stencil is laid over a clean ceramic plate and silver ink is brushed over it. An impression on the plate exactly like the wiring of the circuit is thus obtained, but instead of copper wires there appear a group of silver lines. The silver paint consists of very finely divided silver or silver oxide mixed with a binder to make a paste and thinned with a solvent such as acetone.

After impression of the pattern, the plate is heated to a temperature between 1,300 and 1,500 degrees Fahrenheit, bonding the silver permanently to the ceramic. Paints have been developed which require firing at considerably lower temperatures if desired. The principle advantage which results from firing at higher temperature is exceedingly strong adhesion to the plate.

The resistors are sprayed or painted through another stencil into their proper places or brushed on with a brush. The resistor paint consists of a conducting material such as powdered graphite, and an inert or nonconducting material such as mineralite or powdered mica. These materials are mixed with a binder to form a paste or heavy ink. The resistance may be varied by varying the amount of inert filler or suitably selecting the length, width, and thickness.

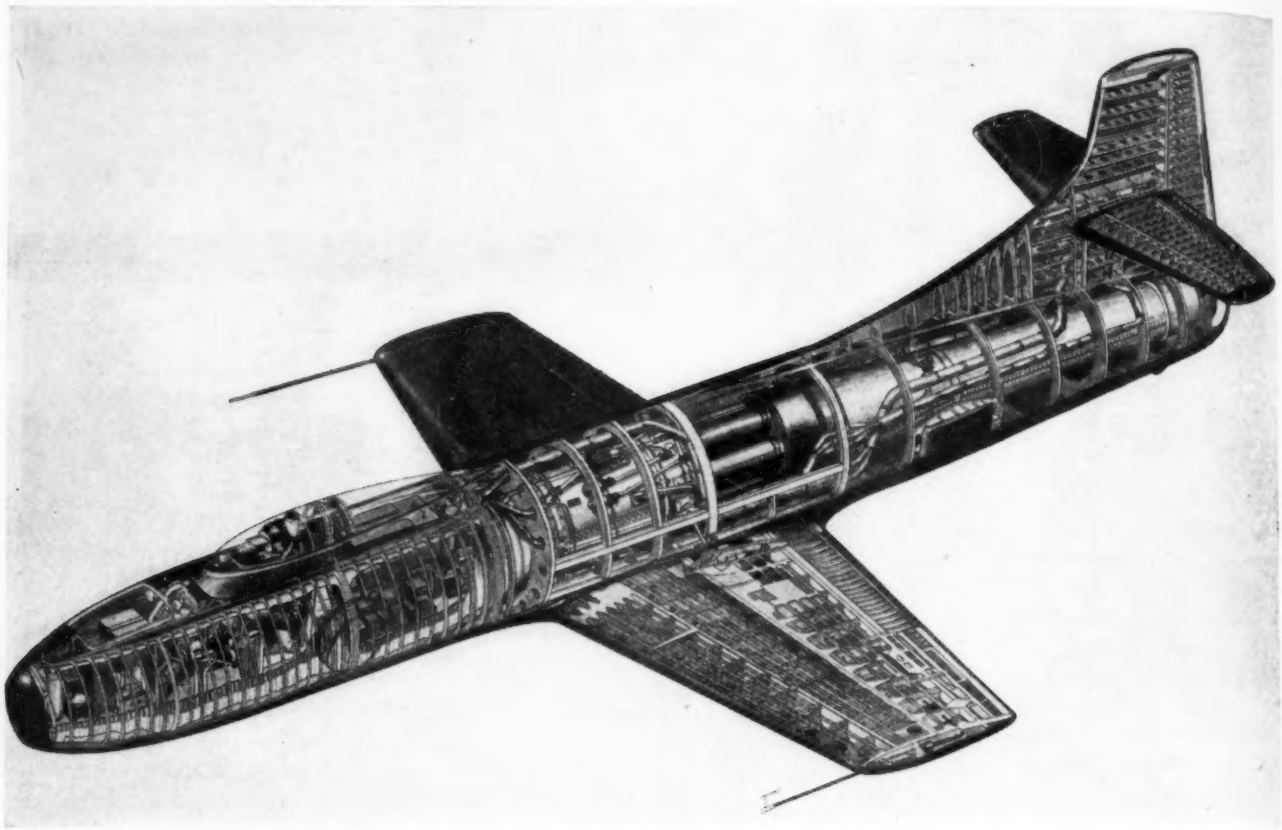
After the resistor paint has been applied, the plate is placed in an oven at 300 degrees Fahrenheit to cure the resistors so that their values will not change with use. A special resin coating is painted over the resistors to protect them against humidity and other effects.

High-dielectric capacitors are then soldered in their proper positions on the ceramic using low-temperature solder. For ordinary radio and electronic application the capacitors are from one-eighth to three-eighth of an inch in diameter and less than four-hundredths of an inch thick. The new subminiature vacuum tubes complete the miniature subassembly.

Uniformity of production, reduction of assembly and inspection time, and reduction of line rejects make the electronic printing processes industrially attractive because large reductions in cost are possible. In present assembly-line practices, wiring represents one of the larger items of production cost. Hence these methods should prove to be desirable for mass production.

Mr. Brunetti and Mr. Franklin are associated with the National Bureau of Standards, Washington, D. C.

New Naval Air Speedsters



Above is a phantom view of the Navy's D-558 Skystreak, a research airplane designed to penetrate into the transsonic speed range. It is driven by America's most powerful turbo-jet engine, the TG-180. Capable of speeds over 350 m.p.h., the Navy XP4M-1 patrol bomber below is powered by two 3,000-horsepower conventional engines and two jet engines in rear of each nacelle (Navy photos).

Founded 1920

ARMY ORDNANCE

Combined with FIREPOWER, *the Ordnanceman's Journal*

Published bimonthly by

THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

Former Editors: J. L. Walsh (Founder), 1920-1922; R. H. Somers, 1922-1925; R. L. Maxwell, 1925-1926; C. R. Baxter, 1926-1929; Leo A. Codd, 1929-1942; R. H. Somers, 1942-1944.

Editor: Leo A. Codd
Managing Editor: R. E. Lewis
Editorial Staff: M. L. Van Horn, J. J. O'Connor, R. P. Hines

Advertising Representatives: Allan E. Shubert Company, 1403 Bankers Securities Building, Philadelphia 7, Pa., and 644 N. Michigan Avenue, Chicago 11, Ill. Atkinson Associates: 68 Post Street, San Francisco, and 6605 Hollywood Boulevard, Hollywood, Calif.

Executive Offices: Mills Building, Pennsylvania Avenue at 17th Street, Washington 6, D. C.

ARMY ORDNANCE, the journal of the Army Ordnance Association, has no official or semiofficial governmental status. All statements expressed in the articles, editorials, and advertisements are those of the authors, editors, and advertisers and do not represent official War Department policy.

MAY-JUNE, 1947

Month By Month

Canadian Ordnance.—The Industry-Ordnance team in Canada has undertaken an extensive program of peacetime activities. A new organization—the Royal Canadian Ordnance Corps Association—has been formed, and a new magazine, *R.C.O.C. Quarterly,* has made its appearance.

The presidency of the new association has been accepted by Victor Sifton, famed Canadian publisher, who served as Master General of Ordnance in Canada during World War II.

The magazine is under the sponsorship of Col. W. G. Denney, Deputy Master General of Ordnance, with Lieut. Col. W. M. Thomson as editor in chief.

All members of the Army Ordnance Association will join in good wishes to the new organization and its publication and will extend every possible assistance in the furtherance of its aims and purposes. Our Canadian neighbors, through generations of coöperation and understanding, have shown us the way to effective achievement in peace and in war.

The Industry-Ordnance relationships have always been close and now, through the medium of the new association, will, we confidently hope, become even closer.

There is other ordnance news on the Canadian front. At a meeting of the board of directors of Canadian Arsenals, Limited, the election as president of Maj. Gen. J. H. MacQueen, C.B.E., of New Glasgow, N. S., former Master General of Ordnance, was ratified and the resignation from the presidency of Col. Malcolm P. Jolley, of Toronto, was accepted.

Colonel Jolley will continue his association with the company on the board of directors. Announcement of the results of the meeting was made by Rt. Hon. C. D. Howe, through whom the Crown-owned company reports to Parliament.

The directors and officers of Canadian Arsenals, Limited, are as follows—President: General MacQueen; directors: Brig. A. Theriault, Air Vice-Marshal A. L. James, Rear Adm. H. T. W. Grant, Colonel Jolley, R. M. P. Hamilton, J. G. Notman, N. P. Petersen, and E. T. Sterne; general manager: Ernest Flexman; secretary-treasurer: D. C. Cullen.

Earlier this month General MacQueen retired as Master General of Ordnance, climaxing a brilliant army career which started with his enlistment as a private in the 78th Pictou Highlanders. He received his commission in the Canadian Ordnance Corps at Royal Military College in 1914 and has held various ordnance appointments both in Canada and overseas. From 1941 to 1945 he was Deputy Quartermaster General at Canadian Military Headquarters in London, England, and held the post of Master General of Ordnance in Ottawa from July 1945 until his retirement.

Mr. Howe paid tribute to Colonel Jolley's service in the following words:

"The setting up of a comprehensive program of industrial preparedness, the primary object of Canadian Arsenals, Limited, was only one of the outstanding contributions Colonel Jolley has made in the service of the nation. Since the early days of the war he has done a job of work which is without parallel. On behalf of the people of Canada I extend to him our heartfelt gratitude."

Mr. Howe stated that for some time past Colonel Jolley had expressed a wish to retire, but would not do so until a successor could be appointed who would be able to devote his full time to the task. Mr. Howe was gratified at the selection of General MacQueen to succeed Coloney Jolley in the presidency.

"With his long years of association in ordnance affairs and his intimate knowledge of the requirements of Canada's armed services, General MacQueen is the ideal man to carry on this important work," he said.

Colonel Jolley was a permanent force officer seconded to the Department of Munitions and Supply. In January 1941 he was appointed general manager of Small Arms, Limited, a Crown-owned company, and on July 22, 1942, was named president of the company. He was chiefly responsible for the efficient operation of the plant in which vast quantities of Lee-Enfield rifles and other small arms were produced for the Canadian and allied forces. On September 14, 1945, when Canadian Arsenals, Limited, was created, Colonel Jolley was appointed president and general manager.

Industry Aids Military Training.—A number of leading manufacturing companies in the U. S. are blazing a trail for the encouragement of military training on the part of their employees. One of the most generous policies to come to our attention is that of the Hughes Tool Company of Houston, Tex.

Under this company policy, an employee may obtain a leave of absence for participation in a summer encampment or other active duty in some branch of military service of one of the states or the United States and also to attend a Citizens' Military Training Camp.

Eligible employees are those who have completed one year of continuous active service with the company prior to being called to summer encampment and who also have completed three months' enlistment in the military organization concerned prior to the encampment.

To all eligible employees the company will grant up to two weeks' leave of absence with pay at the regular rate under existing rules at the time the leave is granted, less the base pay received by the employee from the military organization during his leave.

This leave will be in addition to any regular vacation to which the employee might otherwise be entitled. Only one such leave of absence will be granted to any employee during any calendar year.

This, we hope, will be the pattern to be followed generally by American industry in its attitude toward military training. It is eminently fair, patriotic, and effective. Soon we will all wake up to the fact that military training of our citizen-soldiers is in a precarious plight indeed. Our civilian-military components are far below standard. This applies both to the National Guard and to the organized Reserves. There are many serious problems with which both components are plagued. Some will take a long while to solve. Meantime, the reservoir of trained manhood has shrunk to pitiful proportions.

But let it be said, to the praise of American industry, that with such fine leadership as is shown by the Hughes Tool Company and other large engineering and manufacturing organizations, the question of military leave from one's employment will not be one of the problems. It is to be hoped that countless other companies will promptly follow suit.

Telephones and Bullets.—Just at the time when the world's greatest communications organization—the Bell System—is trying to keep the long lines operating with the employees out on strike, comes word of another problem to make life less happy for those who are responsible for maintenance of the system.

Few of our readers, we imagine, have ever heard that bullet damage to cable facilities is one of the major hazards in long-lines operations. Not all bullets which strike the cables cause service interruptions, but expensive repair work is required to repair the cable sheath regardless of whether the bullet interrupts service or not. Practically all bullets which strike open wire facilities cause service interruptions; if not immediately, the damaged wire eventually breaks down during its change in length due to temperature variations.

Some measure of the seriousness of this destructiveness is evident from an examination of the records of long-lines cable troubles in 1946. These records show that: (1) Two out of every three troubles on pairs in aërial cable were caused by bullets; (2) There were 504 breaks in aërial cable sheath with concurrent pair trouble—96 per cent or 471 of these breaks being caused by bullets; (3) Aërial cables were damaged by bullets at 779 locations.

Usually bullet troubles in aërial cables are caused by caliber .22 rifles. Investigations of the more serious cases often indicate that boys of school age thoughtlessly shoot the cable while hunting. Other cases of bullet damage occur because hunters do not see the cable or are more interested in shooting game on the wing (or sitting on the cable) than they are in protecting the cable. There are also cases of malicious damage, but troubles of this type are relatively few.

Experience in plant maintenance has shown that in the majority of cases damage to telephone facilities by the public has been unintentional. The results of thoughtless acts, such as shooting at a telephone cable because it is a good target, are not generally appreciated by the average sportsman. We believe that the proper approach to a reduction of bullet damage to telephone installations is to acquaint our neighbors along the cable routes with the problem. The most effective approach will be one that is neighborly and associated with their everyday interests.

It seems to us that a very worth-while service can be performed by bringing this situation to the attention of those of our friends—young and old—who are disciples of rifle shooting. Thoughtlessness in this one field of public service, when multiplied the country over, is doing damage to one of the most necessary adjuncts to our modern life. It would be well if members of the Ordnance fraternity passed the word around to their shooting friends to "spare that cable."

German Machine Tools.—Our congratulations to the commanding officer of the Frankford Arsenal and his capable staff for the exhibition of German machine tools, held at the arsenal on March 31 through May 2, 1947. The exhibition was sponsored jointly by the Office of Technical Services of the Department of Commerce, the Ordnance Department of the Army, the Machine Tool Builders Association, and the Army Ordnance Association. The purpose of this exhibition is best told in the words of Maj. Gen. Everett S. Hughes, Chief of Ordnance:

"Since our victory in Europe opened the way to a thorough investigation of German technology, some six hundred representatives of American industry have studied German technical developments in their respective fields. These investigations have been sponsored by the U. S. Department of Commerce, working through the facilities of the U. S. Army's Field Information Agency, Technical, in Germany.

"In the course of their investigations in Germany these experts noted many machine tools and other equipment of novel design and operation. They were earmarked as of special interest to American industry and shipped to this country. They were displayed publicly for the first time at Frankford Arsenal.

"In some cases the investigators were able to report fully on the design and operation of the machines. The reports may now be purchased from the Office of Technical Services, Department of Commerce. In other cases, however, the investigators were not able to obtain full information about the operating details of the machines. A follow-up investigation in Germany may be necessary to supply the information now lacking.

"The purpose of the exhibit was to afford American experts an opportunity to examine the machines critically before a thorough testing program is inaugurated. It is believed that some of them incorporate features which will suggest changes in American practices."

National Security—1947

An Editorial

UNIFICATION of the armed services is now the first order of the day. Lack of a policy on this important question has delayed by nearly two years the formation of our integrated national-defense program. At long last the President has presented to the Congress a plan for utilizing at maximum efficiency our ground, sea, and air forces under the title, "National Security Act, 1947."

¶ Other than granting autonomy to the Army Air Force, the plan does not molest the Army and the Navy as at present constituted. If it did it would not have the approval of many students of our national defense who know the essential value of these great organizations. The plan does not change the function and composition of the United States Marine Corps, without which our national defense would be in sorry plight indeed. In giving the Air Force autonomy, the plan merely recognizes a fact which, since the days of Billy Mitchell, has been obvious to all except the GHQ mind. The Air Force earned its laurels ten times over in World War II. At last the brass is willing to admit that the air is a separate medium for waging battle just as are the land and the sea.

¶ But much more important than any of these considerations are the provisions of the plan for the furtherance of scientific and industrial preparedness. The new plan gives prominence and permanence to those agencies of our national defense which in time of peace are usually forgotten but in time of war become of major importance. They are the Army and Navy Munitions Board, the National Security Resources Board, the Research and Development Board, the National Security Council, and the Central Intelligence Agency. Through these means our national strength or weakness is known. Never again should we allow these functions to be disregarded in peacetime and then, when war comes, have them directed by men who know little or nothing of the antecedents and the problems involved.

¶ Finally, the national-security plan provides for integrating our military and foreign policies. If we as a people do not take steps now, in accordance with the plan, to bring these two vital agencies into close coöperation, we will be false to every obligation that arose from Pearl Harbor. The National Security Act of 1947 is the closest we have yet come to an integrated system of national defense geared to the Atomic Age.

Association Affairs

EXECUTIVE COMMITTEE: Second Meeting of 1947 Held at Washington

The second meeting of the Executive Committee of the Army Ordnance Association during 1947 was held at National Headquarters, Washington, D. C., on March 12, 1947. Present were: James L. Walsh, New York, president; Herbert A. Gidney, Pittsburgh, vice-president; Harvey C. Knowles, Cincinnati, vice-president; C. Jared Ingersoll, Philadelphia, director; Leo A. Codd, Washington, executive vice-president; and Florence G. Ferriter, Washington, secretary. Other members of the staff present were Roger E. Lewis, managing editor of ARMY ORDNANCE; John J. O'Connor, managing editor of LOGISTICS; and Hugh C. Minton, staff consultant for technical committees and divisions.

Preceding the meeting, Lieut. Gen. J. Lawton Collins, War Department, Director of Public Relations, spoke briefly of the plans and policies of the War Department with respect to universal military training. The president thanked General Collins for his kindness in being present and for his enlightening message which is of exceptional interest to the members of the committee and to the Association at this time. Following the General's departure the president called the meeting to order.

The vice-president in charge of local Posts presented a draft of a proposed statement of policy on activities of Posts of the Army Ordnance Association which was unanimously approved. Its text follows in full.

"Paragraph 21 of the by-laws provides: 'Posts of the Association shall be formed wherever there is sufficient interest to warrant their continuation. A minimum of one hundred members shall be required to form a new Post. It shall be their general purpose to cultivate a more intimate understanding of ordnance subjects through meetings, plant visits, seminars, and reports on particular ordnance problems. Their constitutions and by-laws shall be drawn in conformity with the wishes of the members of the Post within the scope of the Association's constitution and by-laws and shall be subject to approval by the national Board of Directors. Local autonomy shall be a guiding principle consistent with the national objectives and policies of the Association. Posts may organize such community groups within their confines as local interest may justify.'

"It will be the policy of the Army Ordnance Association to enhance in every way the value of Posts by encouraging programs of interest not only to members but to the community at large. The function of Posts of the Association is not only to keep alive the ordnance interest and knowledge of members but also to bring to the attention of the general public current problems of our national defense which require the support of a well-informed public opinion. Thus Posts have the dual function of carrying forward the technical and scientific phases of Ordnance progress among members and of performing a public-relations function among the people of our country generally.

"For the accomplishment of these objectives, the following activities on the part of Posts are suggested:

(a) An annual meeting at which current ordnance progress will be reviewed;

(b) Special meetings for the consideration of specific projects of timely importance;

(c) Frequent visits by members to scientific establishments, educational institutions, and manufacturing plants for the study of current techniques;

(d) Service to the community by which speakers qualified to discuss certain authentic problems are made available;

(e) The use of moving pictures of ordnance test and demonstrations, many of which are available through the War and Navy Departments and through technical and scientific institutions;

(f) The encouragement of associate memberships among the students of schools and colleges within the Post area, even to the extent of underwriting the cost of such memberships (associate memberships are $2.00 a year) and of offering prizes among students for ordnance achievement;

(g) The encouragement of close coördination with women's organizations, professional groups, and religious institutions in order that these citizens may be currently informed of the importance of ordnance preparedness;

(h) The use of texts and articles from Army Ordnance Association publications by the press of the local communities and the use of such texts as background information for members of the Posts who address community organizations;

(i) To encourage the formation of community groups within the confines of those Posts which cover large areas, as local interest may justify, thereby facilitating more frequent meetings, such groups or chapters to operate under the general jurisdiction of the parent Post;

(j) Canvass the lists of Post members whose dues are in arrears, or who have resigned, in an endeavor to restore them to active membership in good standing;

(k) Follow the general policy of conducting meetings, lectures, and other forms of seminars;

(l) Encourage enlistment in the Reserve Corps or the National Guard and promote practical training programs, conducting activities to maintain the interest of such Reserve officers;

(m) Upon request of the district chief or other official Ordnance representative, coöperate effectively in measures designed to promote scientific and industrial preparedness;

(n) Designate a vice-president of the Post whose particular function will be to coöperate with the several National Activities Divisions and to coördinate wherever possible the programs of the Posts with those of the Divisions."

AMONG other items of business transacted the president proposed the consideration by the committee of a draft of a plan entitled "National Security Act of 1947." There was unanimity of viewpoint by members of the committee that the proposed bill contains many desirable provisions, notably those in respect of the formation and functions of a War Council, Joint Chiefs of Staff, Joint Staff, Munitions Board, Research and Development Board, National Security Council, Central Intelligence Agency, and a National Security Resources Board.

The national need for these planning agencies and for the integration of military policy with foreign policy is urgent. The autonomy of the respective armed services—Army, Navy, and Air Force—is not infringed upon. Accordingly, the committee recorded unanimous approval of the provisions of the proposed bill. It also unanimously agreed to transmit its views on this subject to the presidents of all Posts of the Association with the request that the governing bodies and members of Posts study

the subject and report their concurrence to the committee at the earliest practicable date.

The president was authorized to appoint a Committee on Honors and Awards, the functions of which will be to nominate candidates to receive the Crozier, Williams, Crowell, Scott, and Rice Medals for 1947 in conformity with the specifications governing the respective awards of these medals. The awards will be made at the Annual Meeting of the Association, the first session of which will be held in New York City on October 1, 1947, to be followed, with the approval of the Chief of Ordnance, by a visit to the Aberdeen Proving Ground the following day, October 2nd.

ARMY AND NAVY MUNITIONS BOARD: A.O.A. Reaffirms Coöperative Efforts for Industrial Mobilization Planning

A meeting of far-reaching importance was held at Washington on March 12, 1947, when, by invitation of Richard R. Deupree, Chairman of the Army and Navy Munitions Board, the Executive Committee of the Association met with the Board to consider plans and policies for the advancement of industrial-mobilization planning.

Also invited to the meeting were officials of the Aircraft Industries Association. In the unavoidable absence of the chairman, Kenneth C. Royall, Under Secretary of War, presided.

Others in attendance were: Hon. W. John Kenney, Assistant Secretary of the Navy; Maj. Gen. S. P. Spalding, deputy executive chairman (Army); Rear Adm. R. W. Paine, deputy executive chairman (Navy); Brig. Gen. P. W. Timberlake, special assistant deputy executive chairman (Army); Rear Adm. H. R. Oster, special assistant deputy executive chairman (Navy); Frank B. Bell, and John Slezak, Army-Navy Munitions Board consultants.

From the War Department were: Brig. Gen. O. R. Cook, deputy director, Service, Supply, and Procurement, WDGS; E. M. Zuckert, special assistant to the Assistant Secretary of War for Air; Maj. Gen. E. M. Powers, Assistant Chief of Air Staff A-4, Army Air Forces; and Maj. Gen. E. S. Hughes, Chief of Ordnance.

From the Navy Department came: Vice Adm. G. F. Hussey, Jr., Chief of the Bureau of Ordnance; Rear Adm. H. B. Sallada, Chief of the Bureau of Aëronautics; and Vice Adm. E. L. Cochrane, Chief of the Materials Division, EXOS.

The Army Ordnance Association was represented by James L. Walsh, president, N. Y. C.; Col. Herbert A. Gidney, Gulf Oil Corporation, Pittsburgh, Pa.; Harvey C. Knowles, Procter & Gamble Company, Cincinnati, Ohio; C. Jared Ingersoll, Philadelphia, Pa.; Dr. John J. O'Connor, managing editor of Logistics, Washington, D. C.; Hugh C. Minton, consultant on technical committees and divisions, A. O. A., Washington, D. C.; and Leo A. Codd, executive vice-president, A. O. A., Washington, D. C.

From the Aircraft Industries Association: J. Carlton Ward, Jr., president, Fairchild Engine & Airplane Corporation, New York, N. Y.; E. B. Newill, general manager, Allison Division, GMC., Indianapolis, Ind.; Rudolf Modley, consultant of the A. I. A., Washington, D. C.; J. E. P. Morgan, A. I. A., Washington, D. C.; W. P. Gwinn, vice-president and general manager, Pratt & Whitney Aircraft Corporation, East Hartford, Conn.; Ray Whitman, vice-president, Bell Aircraft Corporation, Buffalo, N. Y.; H. L. Jennings, General Motors Corporation, Washington, D. C.; and Allen Betts, A. I. A., Washington, D. C.

MR. WALSH, speaking for the Army Ordnance Association, reviewed his experiences in connection with industrial-mobilization planning.

He stated that he was of the opinion that when an emergency arises unlimited appropriations of funds will not overcome the failure to plan properly during the peacetime period. In substance, he felt that we can appropriate funds but not time. In the past, our failure to appropriate funds when there was sufficient time to plan properly has resulted in increased costs of our operations in times of emergency.

To emphasize his point, he presented a chart showing the total appropriations for the operation of the Ordnance Department since the early 1900's. According to Mr. Walsh, this chart illustrated the fact that insufficient funds had been made available to the Ordnance Department prior to each emergency, and, as a result, far greater appropriations had to be made to overcome this failure.

Mr. Ward summarized the general attitude of the Aircraft Industries Association and stated that their problem was slightly different from that of the Army Ordnance Association in that they did not have within the services a counterpart to the Ordnance Department's operating arsenals which are capable of carrying on research and development during peacetime. Because of this fact, research and development had to be carried on largely by industry. Also there was no production capacity, as with the Ordnance Department, on which experimental production methods could be tested.

Mr. Ward further stated that, in his opinion, there was a definite need for a closer tie between combat planners and industrial planners of the War and Navy Departments to ensure the development of realistic plans from industry's point of view. He emphasized that industry cannot perform miracles and, therefore, should not be called upon to do so. He also emphasized that the constant revision of industrial plans is most essential. In his opinion, the current plans and reports on the status of the aircraft industry are already out of date and need revision.

Another essential objective of any industrial plan dealing with the aircraft industry would be to keep those firms engaged in research and development in a healthy condition. This objective is even more important than the maintenance of existing industrial facilities inasmuch as the ability of the aircraft industry to expand is directly dependent upon the development of new plane designs and new methods of production.

In closing, Mr. Ward again emphasized the importance of improving the liaison between the military mobilization planners and the industrial mobilization planners.

The consensus of the meeting was that there are many specific projects wherein the two organizations, together with the Navy Industrial Association, can assist the Army and Navy Munitions Board in the furtherance of its weighty responsibilities. The Board has been assured of this coöperation on the part of the three organizations, and it is expected that specific plans and projects will be announced in due course.

WASHINGTON POST: Conducts Series of Educational Tours of Scientific Establishments

In January, the Washington Post began a unique series of meetings aimed to educate members on the functions and achievements of scientific institutions in and near the Nation's Capital. These visits take place regularly on the afternoon of the last Thursday of the month.

In January, the Naval Research Laboratory was visited; in February the Ordnance Laboratory at the National Bureau of Standards; in March the U. S. Naval Gun Factory. On the schedule for the remainder of the spring series were the Strategic Air Command at Andrews Field, Md., in April and the David W. Taylor Model Basin at Carderock, Md., in May.

By arrangement with Com. H. A. Schade, director, the first postwar meeting of the Washington Post was held at the Naval Research Laboratory, Anacostia, on January 30th. It consisted of a visit to the recently opened exhibit room where a special showing of much of the recent and current work in research and experimental science was conducted by NRL technicians. About 150 members of the Post were present at the 2-hour showing of electronics, crystal formation, infrared "sniperscopes," etc.

The second of the current series of visits to scientific institutions in and about the District was held on February 22nd. Dr. E. U. Condon, director of the Bureau of Standards, and Harry Diamond, chief of the Ordnance Laboratory of that institution, were our hosts. For over two hours the more than one hundred members who signed in at the laboratory were conducted in small groups through several buildings. Development and production of VT fuzes, electronic computing machines, special radio tubes, machining and testing tools, and many other items were explained by the laboratory personnel. Films of guided missiles climaxed the program.

On Thursday, March 27th, the Post visited the U. S. Naval Gun Factory where Rear Adm. T. D. Ruddock, superintendent, invited the Post to a buffet luncheon followed by a tour of the shops of the establishment. More than 140 members attended. Many drove from Charlottesville, Richmond, and Orange, Va. and from Aberdeen, Edgewood, and Baltimore, Md.—F. W. F. GLEASON, *Secretary.*

ABERDEEN PROVING GROUND: Has Active Program of Meetings

The Aberdeen Proving Ground Post of the Army Ordnance Association has recently instituted a series of informal dinner meetings. Short talks about new and pertinent items of interest to members are given at these meetings by qualified guest speakers. In addition, sound motion pictures of recent developments or similar subjects are shown.

The March meeting had as its guest speaker Leo A. Codd, executive vice-president of the Association, who described the detailed operations of the society both in the field of technical and scientific achievement and in public education. After outlining the provisions of the National Defense Act of 1947, he reported that the Executive Committee of the Association had given its approval to the provisions of the act and had requested that all local Posts present their views to the committee. He also described the problems of future activities and policies confronting the Association.

Brig. Gen. A. B. Quinton, Jr., introduced the speaker. Thomas F. Colleran, president of the Post, presided. The attendance was one of the largest in the history of the chapter.

M.I.T.: Association Post Reactivated

On Wednesday evening, March 19, 1947, the Massachusetts Institute of Technology Post of the Army Ordnance Association was officially reactivated after four years. Leo A. Codd, executive vice-president of the Association directed the ceremonies and explained the duties, responsibilities, and privileges of membership.

Also participating in the meeting were Harry Bagnall, a director of the Yankee Post; Prof. Clark Robinson of M.I.T.; Schrade Radtke, former president of the Post; and Lieut. Col. R. S. Crossman, chapter adviser.

The following officers were chosen: President, Thomas W. Folger; vice-president, Andrew R. Pfeiffenberger; secretary, Edwin A. Scott; treasurer, Richard K. Pitler. The following were elected to serve on the board of directors: George J. Hossfeld, John M. Wilson, and John J. Moran, Jr.

The M.I.T. Post was founded in 1922. It was the second local Post established in the Association as well as the first to be set up at an educational institution. The Post has always been among the most active organizations at M.I.T., and it has had a consistenly large student membership. Many former members served with distinction in all theaters during the war. Because of the small number of civilian students at M.I.T. during the war the Post became inactive, but we all hope to build it back to its former position as soon as possible.

Our membership now totals twenty students in the advanced R.O.T.C. course in Ordnance given at the Institute, but we expect this number to be doubled in the coming months. Although all classes are eligible for membership, we intend to take only sophomores, juniors, and seniors.

At present, monthly general meetings are planned and these will probably be in the form of an educational lecture or an interesting field trip.

On April 2nd, Col. D. C. Ludlum of the Watertown Arsenal addressed the Post on the workings of the arsenal, and on Thursday, April 10th, the A.O.A. members took the afternoon off from classes and visited this great Ordnance establishment. We particularly want to thank Colonel Crossman for arranging to give us this chance to get an inside view of an Army Ordnance arsenal.

Our future plans include a trip around the Boston Harbor on an Army mine planter and many other interesting activities. The mine-planter trip is eagerly anticipated by all the A.O.A. members here at M.I.T. However, we shall always bear in mind that our primary purpose is to interest M.I.T. students and graduates in promoting the Industry-Science-Ordnance relationship which is essential to our national security.—THOMAS W. FOLGER, *President.*

PHILADELPHIA POST: Sponsors Machine Tool Exhibit

The spring meeting and rally of the Philadelphia Post, A.O.A., was held at Frankford Arsenal on Friday afternoon and evening, March 28, 1947. Members were the guests of Brig. Gen. Edward E. MacMorland, commanding general at Frankford. High light of the occasion was a preview of a special exhibit of wartime German machine tools in actual operation. This was preceded by a tour of the small-arms ammunition plant.

A general meeting of the Post was held at 5 P.M. at which C. Jared Ingersoll, president, presided. The principal speaker was James L. Walsh, president of the Association. He stressed the important place held by Frankford and the other Ordnance arsenals in keeping alive the art of ordnance design and production in time of peace. He displayed startling figures showing the tremendous expenditures required for ordnance in time of war and the meager appropriations it is our custom to provide in time of peace. He urged a militant crusade to make certain that we do not repeat again the mistakes we have made consistently in the past.

The John C. Jones Gold Medal, presented by the Post for distinguished service to Ordnance, was awarded to William J. Meinel, president of the Heintz Manufacturing Company of Philadelphia. Mr. Meinel was cited for his outstanding record in the design and production of ordnance in war and in peace. The medal is in memory of John C. Jones, first chief of the Philadelphia Ordnance District in World War I, one of the founders of the Army Ordnance Association and long a member of its Board of Directors.

The following officers were elected, after which a buffet supper was served: W. J. Meinel, president; G. W. Elliott, D. N. Hauseman, C. J. Ingersoll, and T. D. Barney, vice-presidents; W. F. Feustel, secretary-treasurer.

The following directors will serve until 1948: G. W. Elliott, H. W. Gadsden, H. P. Gant, A. W. Gilmer, L. E. Hess, Ralph Kelly, E. J. Langham, R. P. Page, and Wilbert Wear. The following directors will serve until 1949: G. M. Barnes, E. G. Budd, Jr., C. A. Godshalk, D. N. Hauseman, C. J. Ingersoll, W. J. Meinel, W. C. Pew, Jr., and C. S. Redding.

BOSTON: Hears about Guided Missiles

Col. Leslie E. Simon, director of the Ballistic Research Laboratory, Aberdeen Proving Ground, was the principal speaker at the second meeting of the 1947 session of the Yankee Post held at the Boston City Club on April 15, 1947. He shared the rostrum with James L. Walsh, president of the Association.

Colonel Simon described many details of the guided-missile tests now being conducted at the White Sands Proving Ground,

N. Mex. Mr. Walsh described the plans of the Army Ordnance Association for assisting the advancement of industrial-mobilization planning.

Arrangements for the meeting were made by a committee of officers and directors consisting of Carl F. Carlstrom, H. W. Bagnall, F. W. Knauth, H. S. Chafee, Ralph Gow, R. N. Greenwood, J. L. Martin, Richard Morse, C. S. Robinson, Joseph Spang, Jr., G. W. Sweet, Thomas West, and G. P. Slade.

NEW YORK POST: Black Ties Give Way to Beer and Sandwiches

As many members of the New York Post, A.O.A., were turned away from the March meeting as were able to get in. The assembly hall of the Columbia University Club in New York holds 350 people. It was jammed to the doors for the spring meeting of the Post when a galaxy of stars appeared on the program. Exactly 350 members had their reservations and checks returned to them for lack of accommodations.

The star program included Maj. Gen. Everett S. Hughes, Chief of Ordnance; Vice Adm. George F. Hussey, Jr., Chief, Bureau of Ordnance, U. S. Navy; Brig. Gen. Donald Armstrong, an executive of the American Standards Association; and Col. Leslie E. Simon, director, Ballistic Research Laboratory, Aberdeen Proving Ground. The Navy's colored moving picture, "Operation Crossroads," was also a feature.

Harry M. Tillinghast, president of the Post, presided at the meeting and introduced the speakers. General chairman of arrangements was D. B. MacMaster. Greetings to the assembled guests were conveyed by the Ordnance District Chief, Col. Edward Gluck. Following a highly intellectual and enjoyable program, the guests, contrary to New York protocol, were served sandwiches and beer.

The meeting committee consisted of Colonel Gluck, chairman; Hartley W. Barclay, Francis E. Barkman, C. Stewart Comeaux, George L. Cory, A. W. Duffield, Norman Gilroy, Edward Lazar, D. B. MacMaster, Alexander Marks, Chester Mueller, T. E. Murray, Jr., B. R. Olmsted, H. Robert Samstag, Don H. Taylor, H. M. Tillinghast, J. L. Walsh, and Stuard Wurzburger.

ANOTHER GOOD BOOK: History of New York Ordnance District

A history of the New York Ordnance District, written by Col. Chester Mueller, is now on the press. Colonel Mueller served as chief of the district during the latter phases of World War II. He is a Reserve officer of eminent attainments, a lawyer by profession, and he has had many years of contact and service at N.Y.O.D. in peace and in war. He is well qualified to write the history of the district which he has done thoroughly and entertainingly.

It is expected that the book will be ready for delivery about August 1st. It is published under the auspices of the New York Post, A.O.A., and you will read a great deal more about it in the next issue. It is the record of a great Ordnance organization made possible by the united efforts of thousands of individuals and companies. Every student of ordnance preparedness will want to have a copy of it handy for future reference. Watch the columns of this magazine for further announcement.

B. B. PATTON: Spoke on Gages at Annual Meeting

The remarkable ease with which the entire gage industry of the United States was mobilized far in advance of the actual production programs of World War II and the efficiency with which the industry met its phenomenal wartime requirements was the subject of a paper presented by B. B. Patton, director of the Ordnance Gage Laboratory, Frankford Arsenal, at the Annual Meeting of the A.O.A. in 1946. Reference to this address was inadvertently omitted from the proceedings of the meeting as published in this journal.

In discussing the wartime gage program, Mr. Patton said: "We hear and read much about the production of instruments of war and the astronomical figures on production of ammunition, but little, if anything, is mentioned concerning gages. The average layman has no conception of the important part gages played in the war effort nor the vast quantities of gages produced. This may be because we produced the gages in enough quantities and *on time*—not too little or too late.

"From the first, the Ordnance Department of the Army recognized the magnitude of the problem involved and established the necessary organizations, policies, and procedures for carrying out the design, procurement, and distribution of the gages for all Ordnance items. With the wholehearted coöperation of the gage industry, the Ordnance Department brought about an expansion program which made gage capacity available not only for the Ordnance Department itself but also for all the defense services for industry and for the several allied countries under the Lend-Lease programs. The gage-making capacity was increased by more than 3,000 per cent and those who made such an increase possible are to be commended for their part in this herculean task.

"As you all know, many thousands of gages were designed and millions were procured by the Ordnance Department, the Navy Department, and the Air Corps, and industry required many more thousands of working gages. These gages were maintained, inspected, distributed and redistributed to thousands of facilities. The quality of the matériel which was accepted by the Ordnance Department has been the ultimate proof of the success achieved by the Ordnance-Industry gage team.

"At the present time we are not prepared properly to discuss gage production planning of the future. Scientific developments in weapons are creating problems, making it impossible to obtain any production-planning information upon which we could even guide you as to what production capacity might be required in the gage industry in the event of a war. One lesson along the lines of gage production capacity we learned from World War II was consideration of more specialization in gage manufacture in the event of another emergency. We all know why it was not done during that war. Industry has to expand so much and at so fast a rate that the gage production has to be very versatile in most facilities in order to develop skills.

"Specialization by types of gages by certain war production facilities is not conducive to development of all-around skills. But we do know that it does lead to man-power economies in gage production. In World War II we specialized one facility in the production of chamber gages for artillery ammunition. This was a great advancement, as it led to quick deliveries, manpower savings, and price reduction in chamber gages. We do know that we want gage production planning to consider specialization in the manufacture of small-arms chamber gages and profile gages. Never during the war did we have an overabundant supply of small-arms chamber gages of high quality, due to the lack of facilities competent to fabricate such gages within the small tolerance limits."

NECROLOGY

Notice has been received of the deaths of the following members of the Association: R. S. Bishop, Flint, Mich.; L. A. Daines, Chicago, Ill.; R. P. Dony, Rochester, N. Y.; Arthur Dorrance, Camden, N. J.; T. O. Duggan, Santa Anna, Calif.; C. H. Fawcett, Louisville, Ky.; C. B. Goodspeed, Chicago, Ill.; C. T. Hoover, Corona, Calif.; A. E. Johnson, Omaha, Nebr.; M. C. Knox, Hyattsville, Md.; S. G. McAllister, Chicago, Ill.; E. A. Munger, Muncie, Ind.; A. G. Olsen, Omaha, Nebr.; J. E. Pew, Philadelphia, Pa.; Valentine Simons, Harrisburg, Pa.; E. M. Sternberg, Milwaukee, Wis.; J. H. Walters, Jamestown, N. Y.; Carl Weinhauer, Wellsville, N. Y.; C. M. Yoder, Cleveland, Ohio; C. M. Young, Detroit, Mich.; and B. C. Ziegler, West Bend, Wis. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

Professional Digest

REPORT FROM WILLIWAW

The Army's Task Force Williwaw recently tested the 155-mm. Long Tom gun for mobility and stability on the soft tundra of Adak in the Aleutians. On the day the gun was to be towed off the road for the first time, there were some observers who doubted that it would ever regain the road. They had already seen how a comparatively light vehicle, once it had broken through the surface mat of vegetation, would sink to its axles in the mushy tundra. They had seen a man push a half-inch steel rod ten feet into the soft, yielding ground hand over hand, like climbing a rope!

As soon as the gun rolled onto the tundra, the vegetation parted and the bogies sank to a few inches below the hubs. The piece crept forward, its wheels, unable to rotate, acting like blunt plows. After about thirty yards the prime mover lost traction—a high mound of vegetation and muck had piled in front of the wheels and carriage of the gun. A second tractor was hitched in tandem, and, by angling the gun sharply, a large portion of the spoil was left behind. Using this "angling-off" method, the piece was moved to the point of emplacement.

The gun was emplaced in the normal manner and twenty-six rounds fired at various elevations and degrees of traverse. Rearward movement after 3 rounds was 23 inches; after the next 12 rounds, an additional 14 inches. By this time the carriage and trails were so completely buried that no movement occurred during the firing of the remaining rounds. Such stable emplacement, though highly desirable, was considered unsatisfactory due to the difficulty and time needed to extricate the piece. It required 3½ hours and the effort of 3 tractors, plus the winch of a 7½-ton truck, to pull the gun from this position!

THE northern tip of Adak Island, which Task Force Williwaw used for its proving ground, is covered with a rich, matted growth of grass, moss, and lichens. This carpet of plant material obstructs or entirely prevents the normal drainage of this area, and a near swamp is the result. A break-through of this vegetation in coastal areas reveals a sandy base; inland, the top soil is a black muck.

The standard prime mover for the 155-mm. gun, the high-speed tractor M4, was not available. The M6 tractor was substituted and performed satisfactorily on the road, but on soft tundra it became hopelessly mired. On firm tundra it could move only in a straight path and could not be maneuvered out of its own ruts, which were five inches deep.

The low-speed (engineer) tractors, TD14 and D7, were found suitable for off-road towing. These tractors were equipped with special tracks. The TD14 moved on 30-inch tracks with 5-inch grousers and the D7 on 40-inch tracks with 6-inch grousers.

It should be mentioned that the off-road mobility tests were primarily conducted for the purpose of reaching a suitable firing position as near to the road as possible. Long-distance tundra passages were limited by the mountainous nature of the surrounding terrain.

Since these tests were held during December and January it would seem reasonable to assume that the Aleutian winter should be severe enough to freeze the subsoil. However, this is not true. The average minimum temperature for the winter months during the past three years was but 29 degrees Fahrenheit. These surprisingly moderate temperatures are a result of the Japan Current which flows not many miles south of the island. During a spell of subfreezing weather the mud becomes frosted, though not frozen, to a depth of two to three inches. A man can stamp his heel through this. Thus, the thick layer of vegetation provides effective insulation against the cold.

THERE followed a series of tests using the artillery sled M10 on the bogies of the Long Tom and the sled M5 on the limber. The sled M10 is thirteen feet in over-all length. The forward upturned section is hinged to the main part of the sled, an undesirable feature when used in mud. The M5 is a rigid sled approximately thirteen feet long. Both of these sleds are constructed of steel.

The gun mounted on sleds presented a number of difficulties, but flotation was so greatly improved that it appeared that the problem of off-road mobility was headed toward solution. However, when towed in the normal manner the limber refused to follow the prime mover in a turn of fifteen degrees or greater. The limber sleds, riding in 2-inch ruts, dug in edgewise and there was danger of damage to the limber components if greater effort was applied in order to accomplish the turn. The forward hinged section of the M10 sleds folded upward and "bulldozed" enough mud to stall the prime mover.

To have attempted removal of the bogie sleds for emplacement would have necessitated the impractical job of replacing them after firing with the bogies deep in mud. Therefore, subsequent tests were planned with the idea of leaving the sleds attached during emplacement and firing.

Emplacement with sleds attached in the normal manner produced several difficulties. The upturned tips of the sleds interfered with the spreading of the trails, and the front spades resting above the sleds could not be emplaced. The carriage, when lowered, rested on the inside edges of the sleds.

Many of the difficulties of mobility and emplacement were overcome by a simple improvisation: The sleds were reversed; *i.e.*, turned end for end.The piece, now towed muzzle first, was able to negotiate a circle seventy-five feet in diameter. The bogie sleds were modified to obtain rigidity which prevented the forward hinged section from bulldozing. In place of the limber, an M5 sled was chained under the trails. This was necessary because, in muzzle-first towing, the limber, riding free, otherwise swung from side to side depending upon which sled was subject to the greatest resistance.

A sled was later constructed to replace the M5 for more effective attachment to the trails. These changes enabled the TD14 to tow the piece effectively over flat and gently rolling terrain.

With sleds reversed, previous difficulties of emplacement were also overcome. The trails could be spread and the front spades employed. The rear inside corners of the sleds which still interfered with lowering the carriage were cut off.

Satisfactory stability was achieved by the employment of trail logs. One 8x8-inch timber, fourteen feet long, was dug in behind both front spades. Trail logs five feet long were used behind each trail spade. It was found that special spades with floats were needed to prevent the trail logs from escaping.

Twenty-one rounds were fired from this emplacement, and the total rearward movement, not including the first seating round, was 13½ inches. Length of recoil and time of the recoil cycle were normal. Firing mechanism, sights, equilibrators, and elevating and traversing mechanisms functioned satisfactorily. Lubricants used were standard and proved satisfactory. With the moderate temperatures prevailing at Adak, failures of functioning due to cold were nonexistent.

To tow the 155-mm. gun 200 yards off the road and emplace it in firing position required approximately 3 hours. Thus a method was devised which made off-road mobility feasible and at the same time made removal of the bogie sleds for emplacement unnecessary.—MAJ. D. VEZZOLI, *Ord. Dept.*

Little known facts about ordnance

DID YOU KNOW THAT . . .

The Sioux who massacred Custer in 1876 were so much better armed than our cavalry that they did not bother to remove the Spencer repeating carbines from the field?

Union Ordnance troops found on the field of Gettysburg nearly 3,000 muzzle-loading rifles—each with two to twenty unfired cartridges in their barrels?

Breech-loading, flintlock rifles were used in the American Revolution by Major Ferguson's British sharpshooters at King's Mountain, 1780?

Violent protests were caused by the use of booby traps in the American Civil War (General Magruder incorporated them into roadblocks while defending the Yorktown Peninsula, 1862)?

The police and military of nine American nations to the south of us are now dependent for parts and replacements of all their small arms (Mauser) on Soviet-controlled sources?

The Sultan of Mysore, India, by using a rocket corps of 5,000 men against the British, 1799, was responsible for the introduction of this weapon in effective form into European warfare?

Confederate Ordnance troops recovered several hundred tons of lead in the form of spent missiles from the battlefields of Chancellorsville-Wilderness-Spotsylvania?

Turkish troops in their war with Russia, 1877-1878, were armed with American rifles—600,000 Peabody-Martinis made by the Providence Tool Works?

Railway artillery was first used (the idea of R. E. Lee) in the Seven Days Battles around Richmond?

The first use of shell in naval warfare was in 1855 when the Russians annihilated a Turkish squadron?

Napoleon Bonaparte, on entering the French Academy of Sciences, 1797, delivered a paper on the "Use of the Automobile in War" based on Captain Cugnot's steam tractor for artillery hauling (perhaps the earliest serious military consideration of mechanization)?—*Prepared by F. W. F. Gleason.*

Atomic Energy

ANALYSIS OF URANIUM

The utilization of uranium as a source of atomic energy requires material of the highest purity, because impurities may prevent the nuculear chain reaction through which atomic energy is released. Thirty-three impurity elements, some in concentrations as low as a few tenths part per million, have been detected and estimated through a modified spectrographic method developed at the National Bureau of Standards and used since 1942 in the Manhattan Project for analysis of uranium and its compounds. Solving a major analytical problem, the method has been applied by the National Bureau of Standards to control and inspect the production of these materials.

Early in 1941, at the request of the Office of Scientific Research and Development the Bureau of Standards undertook to adapt spectrographic methods to the analysis of uranium. In developing suitable methods it was evident that the interference of the spectrum of uranium, with the spectral lines characteristic of impurities, could be overcome only by separating the impurities from the uranium. This was accomplished in the carrier-distillation method by converting the uranium sample to a refractory compound having low volatility (the black oxide of uranium, U_3O_8) and distilling the impurities from this compound in a direct-current electric arc.

In order to sweep out the minute quantities of impurity vapors from the sample without volatilizing the uranium, a small amount of a volatile material, termed a "carrier," is added to the sample. Gallium oxide, a compound of a rare metal resembling aluminum, was found most useful as a carrier and is added at a concentration of two per cent in the uranium oxide. When the mixture is heated by a direct-current arc in a carbon electrode of special design, the carrier material and impurities are volatilized into the arc. The uranium, remaining as a residue, can be recovered readily from the electrode—an important consideration, particularly with some active forms of uranium.

The light of the arc, examined with a spectrograph, provides a spectrum consisting of the simple spectrum of gallium plus the spectral lines characteristic of volatile impurities in the uranium.

For quantitative determinations, carefully prepared standards of known composition are submitted to the same treatment as the samples. Amounts of impurities are then estimated by photometric measurement or by visual comparison of the spectrograms of samples and standards.—B. F. Scribner and H. F. Mullin.

ATOMIC POWER FOR AIRCRAFT

Following completion of a highly important 10-day seminar on nuclear physics with emphasis on the application of atomic energy to the propulsion of aircraft, held at the Fairchild NEPA Project (Nuclear Energy for Propulsion of Aircraft), at Oak Ridge, Tenn., it was indicated that important initial progress had been made in a program which may eventually revolutionize present concepts of aviation.

Prime contractor with the AAF for the NEPA Project is the Fairchild Engine and Airplane Corporation, presently associated with nine other aircraft power-plant companies as well as with the National Advisory Committee for Aëronautics. Additional private laboratories and universities are being brought into the program to contribute to the extensive research and development necessary. Great care has been taken to make use of existing facilities and to avoid duplicating present efforts.

The field of nuclear science is so new and the problems of nuclear energy so complex that it will be some time before major accomplishments can be reported. The program is well under way, however, and basic studies covering fundamental nuclear, thermodynamic, metallurgical, ceramic, and aërodynamic problems are in process.

The following companies, all active in the field of aircraft power plants, are coöperating with Fairchild in the project: Allison Engine Division of General Motors, Continental Motors Corporation, Fredric Flader, Inc., Lycoming Division of Aviation Corporation, Menasco Manufacturing Company, Northrop Aircraft, Inc., Pratt & Whitney Aircraft Division of United Aircraft Corporation, Westinghouse Electric Corporation, and Wright Aëronautical Corporation.

The Army and Navy Air Forces are jointly interested in the project although it is administered under AAF contract.

TESTING GEIGER-MÜLLER COUNTERS

A new laboratory to test Geiger-Müller counters and associated electronic measuring equipment has been established in the radioactivity section of the National Bureau of Standards. Called into being by the growing demand for reliable, stable instruments, the laboratory will test performance qualities, utility, and construction of counters now being manufactured.

The fields of science dealing with radioactive matter and isotopes have grown far beyond that of physics to include biology, chemistry, and medicine, in addition to fast-developing industrial uses. In all these areas of investigation, the Geiger-Müller counter has become a critical piece of equipment, although commercial production has been undertaken only in the past nine or ten months.

Research uses for the counters include detection and numerical measurement of particles emitted in experiments involving nuclear radiation, transmutation, and disintegration.

Because of the possible types of counters available, writing specifications for a particular instrument may be difficult for the researcher lacking the background of the physicist or the electronics engineer. The problem is further complicated by the fact that it is unusual for successive counters made even by the same manufacturer to be alike in every detail. Improvements and advances are made rapidly in this field and can quickly be incorporated in a counter under construction. The new laboratory, in its testing, will attempt to bridge the gap between the manufacturer and the user, providing for expert determination and study of efficiency, stability, uniformity, and sensitivity of counters.

ATOMIC POST FILLED

Col. James McCormack, of the Army Engineers, was named director of the Division of Military Applications, Atomic Energy Commission, on January 31, 1947. In this key post Colonel McCormack will take over many of the duties previously executed by Maj. Gen. Leslie R. Groves, former chief of the atomic-energy project.

On the same date General Groves was named to succeed Maj. Gen. Lunsford E. Oliver as a member of the Military Liaison Committee to the Atomic Energy Commission. General Groves and Lieut. Gen. Lewis H. Brereton, chairman of the Military Liaison Committee, are the Army members of the Committee.

The Commission intends to use the Director of Military Applications not as a mere operator but as a full staff member who will specilize in military problems but also participate with other staff members in reviewing, planning, and evaluating all phases of the Commission's work.

A report to Congress by the Commission states that the Division of Military Applications assumes a far more important position in relation to the entire program of the Commission than would be the case if it were merely a line operating division concerned only with supervision.

Ordnance Glossary

Some Explanatory Notes on the Ordnance Department and Ordnance Matériel—Part III

F. W. Foster Gleason

THIS compendium of ordnance terms has been compiled as an aid to the readers of ARMY ORDNANCE and to all students of armament in interpreting properly the terminology of the literature.—EDITOR.

---

half-track: A combination wheeled and track-laying vehicle, usually having the drive track in the rear.

hardstanding: Any open area which has been surfaced with a hard material—usually referring to Ordnance installation for open storage.

howitzer: An artillery weapon having a medium-length barrel, high trajectory, and medium velocity. The howitzer has certain advantages over the gun and, of course, disadvantages. Its lighter and shorter barrel enables it to throw a far heavier shell for a shorter range than a gun of equal weight and its high-angle fire reaches targets that are protected from the gun, its propellent charge is, in general, more flexible, and its portability in the smaller sizes enables the howitzer to go where the gun cannot readily be taken. The types of howitzer used in World War II were:

The 75-mm. pack howitzer M1A1 on pack carriage M1 which was designed to be transported on six horses or mules when broken down into six loads averaging 232 pounds each. On carriage M8 it is a standard weapon of air-borne troops, and its breakdown for air transport results in seven loads (including crates) of an average weight of 259 pounds. When on carriage M3A3, it becomes a standard light field piece of the cavalry division. The 18-pound shell of this weapon, ranging for 9,600 yards and fired at a rate of 6 a minute, plus its flexibility of mounting, makes it a notable, though not a major weapon.

The 105-mm. howitzer M2A1 has replaced the "75" as the standard light artillery weapon of the infantry division and its ability to throw a 33-pound shell for more than 12,000 yards, to handle high-explosive, chemical, smoke, and armor-piercing ammunition, and to be towed at 35 miles an hour has earned it the sobriquet of "workhorse of the artillery." Its traveling weight is 4,980 pounds. A lighter version, designed for the infantry cannon company and capable of being air-ferried, is known as the M3. It throws the same projectiles to 8,295 yards and weighs but 2,673 pounds when traveling on its high-speed carriage M3A1.

The 105-mm. howitzer M1 represents the medium artillery of this type. Nearly 14 pounds of powder hurls the 95-pound shell to a distance of 16,355 yards (made possible by a barrel that is considerably longer and heavier than on previous models) yet it is emplaced in 5 minutes and its complete weight of 12,800 pounds is towed at high speed on the M1A1 carriage.

The 8-in. howitzer M1 is designed to throw a 200-pound shell for more than ten miles, its plunging fire being effective against heavy fortifications and bridges. Its 30,000 pounds are towed in one load by either a 7½-ton truck or the 18-ton high-speed tractor M4.

The 240-mm. M1 "Black Dragon" packs the heaviest punch of all American field-artillery weapons. Its 360-pound shell with

49.71 pounds of TNT is propelled for nearly 14½ miles by 78½-pounds of powder. The 25,100-pound tube and breech and the 32,100-pound carriage are transported in two loads, each towed by a 38-ton high-speed tractor M6 and accompanied by a truck-mounted crane with clamshell bucket for emplacing the gun. The power, reliability, and mobility of this weapon make it the "queen" of mobile artillery.

hydropneumatic: Term used when air, nitrogen, or any other gas is used with oil or glycerin to function a recoil mechanism. Generally, the oil or liquid absorbs recoil, and the gas returns the barrel to battery position.

hydrospring: Term used when a steel spring and oil or glycerin are used to function a recoil mechanism. The spring is used to return barrel to battery.

idler: A nondriving wheel of a tracked vehicle at the opposite end from the drive-sprocket wheel. It may be adjusted to tighten the track.

igloo: An ammunition-storage magazine built of concrete and earth and having vaulted roof.

igniter: A charge, usually of black powder, used to set off the explosive charge of some projectiles, grenades, mines, and other types of propellent charges. The igniter is fired by a primer.

increment: An addition to a propellent charge, usually in the form of a powder bag, in the case of semifixed or separate-loading ammunition, or a pellet or ring of compressed powder in mortar ammunition.

inertia fuze: Usually of the base-detonating type. The firing pin, carried on an inertia block, is driven forward by inertia upon shock of impact.

JANET Board: Contraction of Joint Army-Navy Experimental and Test Board.

lead azide: A highly brisant explosive, very sensitive to flame. It is used as an initiator for the detonation of less sensitive high explosives.

line item: A one-line entry on an Ordnance requisition indicating the desired quantity of a single item.

liner: A separate inner tube, lining a barrel and carrying the rifling; in most cases the liner is removable for replacement of rifling.

Livens projector: A tube for the throwing of gas shells. Buried in the ground in large groups, it was widely used in World War I to flood areas with gas.

machine gun: A full-automatic small-arms weapon, fired from any mount; in the first World War American troops used some Lewis, Vickers, and Marlin machine guns, largely for aircraft. But our principal ground machine gun was the Browning caliber .30 M1917, the caliber .50 being developed too late for war service. In World War II our standard machine guns were Browning caliber .30 M1917A1, air- and water-cooled; Browning caliber .50 water-cooled for antiaircraft use; and several models of the same gun, air-cooled, for ground, vehicle, aircraft, and antiaircraft use. Many of the latter type were installed in quadruple mounts and sometimes in combination with small antiaircraft cannon.

maintenance: Consists of care taken and work performed to keep any item of matériel in good working condition. First-echelon: preventive maintenance performed in any location by the wearer, user, or operator of any equipment. Second-echelon: additional maintenance performed by the unit which includes maintenance work beyond the skill of the individual user (first- and second-echelon work is known as organizational maintenance.) Third-echelon: maintenance work performed by maintenance and supply organizations in close support of using troops. Fourth-echelon: maintenance performed by an established pool of service units; it serves all forward echelons, has larger stock of tools and parts, is a semifixed shop, and rebuilds major items. Fifth-echelon: performs complete reconditioning and limited manufacture and uses fixed installations. (*To be continued.*)

Book Reviews

Review Staff

BRIG. GEN. DONALD ARMSTRONG, *military historian, lecturer, author, New York, N. Y.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

LIEUT. COL. CALVIN GODDARD, *small-arms authority, Washington, D. C.*

CAPT. MELVIN M. JOHNSON, JR., *automatic arms expert, inventor, author, Boston, Mass.*

BRIG. GEN. R. H. SOMERS, *engineer, ballistician, author, editor, Dover, N. H.*

COL. THOMAS K. VINCENT, *artillerist, engineer, author, Springfield, Mass.*

THE RIFLE IN AMERICA. By Philip B. Sharpe. New York: Funk & Wagnalls Company. 782 pp. $15.

THIS is a completely revised and greatly enlarged edition of Phil Sharpe's earlier work of the same title, the first edition of which was published in 1938. The original edition has been brought up to date, its very few inaccuracies corrected, and its scope broadened considerably. This edition is graced with a foreword by Maj. Gen. Julian S. Hatcher who is well qualified by his intimate friendship with the author and with the subject matter of the book to write at length on both. We shall not attempt in this notice to analyze the text material—a task which was performed in these pages some years ago by more competent hands.

It is our purpose here to pay our respects to the author for his tireless energy and unusual skill. Phil Sharpe is a persistent searcher for facts and figures on American small arms. "The Rifle in America" is a mammoth undertaking. So, too, was his earlier work, "A Complete Guide to Handloading." Together these volumes are an important part of the small-arms literature of the United States. They will be read by increasing numbers of the small-arms fraternity—that hardy band with an insatiable appetite for information on guns and ammunition.

We hope Phil Sharpe will continue to publish his studies in a field in which he has few equals.—L. A. CODD.

THE MEETING OF EAST AND WEST. By F. S. C. Northrop. New York: Macmillan Company. 531 pp. $6.

THE most important ideological conflict confronting our world is the one rendered inescapable by the major event of our time—the meeting of East and West. Within the all-embracing and deep-rooted issues raised by this momentous occurrence the other ideological conflicts of our world are partial components. Hence the title of this book.

Professor Northrop insists that current problems must first be traced to their roots and then resolved in theory. The present inquiry, therefore, turns out to be philosophical in character and falls into two major parts: the one, a determination of the differing ideological assumptions of the major peoples and cultures of the West, culminating in a chapter on the meaning of Western Civilization; the other, a similar study of the major peoples and cultures of the East.

The "GREENFIELD" Threading Team

From the metallurgist, who tests the steel from which "Greenfield" Taps, Dies and Gages are made, to the field engineer who helps the user get the most production out of "Greenfield" Tools—there is a highly trained organization of "Greenfield Men". Together they make the "Greenfield" Threading Team an outstanding contribution to the efficiency of the metal-working industry.

GTD GREENFIELD

GREENFIELD TAP and DIE CORPORATION • GREENFIELD • MASSACHUSETTS

BUYER—SELLER COOPERATION AT THE PLANNING LEVEL GIVES THE BEST STEEL CASTINGS

Cast steel parts of optimum value and minimum cost result from close cooperation between designer, patternmaker, and foundryman. We are prepared to work with you by

1. **Consulting on design at the planning level.**
2. **Making pattern layouts and inspections.**
3. **Pouring and X-raying pilot castings to make sure of internal soundness.**
4. **Checking pilot castings for dimensional accuracy.**

RACINE STEEL CASTINGS CO.

Division of Belle City Malleable Iron Co.

RACINE, WISCONSIN

S R C

RACINE STEEL CASTINGS

Book Reviews

This analysis permits the fundamental problem underlying the ideological conflict between the traditional East and the traditional West to be determined and also serves as a guide to its solution.

Professor Northrop's solution defines a more inclusive, truly international, cultural ideal which provides scientifically grounded intellectual and emotional foundations for a partial world sovereignty. This ideal also defines the criteria for relating democracy and communism, Catholic medieval and Protestant modern values, and Occidental and Oriental institutions in order that they might support and sustain rather than combat and destroy one another. This important study will be richly rewarding to those who desire to probe beneath the surface of national and international conflicts.—JOHN J. O'CONNOR.

AMERICAN SEA POWER. Edited by Allan Wescott. Philadelphia: J. B. Lippincott Company. 609 pp. $5.

THIS fine book is a comprehensive history of the activity of our Navy from the beginning of the Revolution up to the end of the past war. It explains the effect the Navy has had on our national history, its employment in support of our foreign policies, and emphasizes the vital responsibility the Navy will have in any future emergency.—R. P. HINES.

MAUSER RIFLES AND PISTOLS. By Walter H. B. Smith. Harrisburg: The Military Service Publishing Co. 234 pp. $5.

IN HIS latest contribution to the N.R.A. Library, W. H. B. Smith has compiled not only the story of the weapons but also the history of Peter Paul and Wilhelm Mauser. He has elected to focus upon the historical aspect—and well he may—for the name of Mauser is closely connected with the military record of eighty years.

The volume's prize package is in a 3-page "author's note." Here is brought out the immense part which the world-wide distribution of this famous line played in the spread of German commerce and influence. And, more to the point, he answers the $64 question—"Who takes over now?" He shows just what it means that the police, the military, and the sportsmen of twenty-one nations (nine of them in our own hemisphere) are saturated with the Mauser tradition and are absolutely dependent upon those who can supply replacements, parts, and service. His demonstrated assertion is that the bulk of Mauser-type plants are under Soviet control. Fabrique Nationale of Belgium is the sole important exception, and it cannot begin to fill legitimate demands.

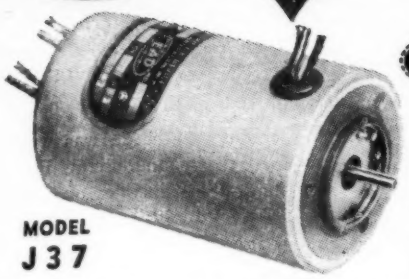
Most of the book is devoted to a description of Mauser arms from 1867. Some few details of late models seem to be missing, a few contradictory statements appear to be the result of haste in assemblage, and the lack of an index is unfortunate. But the author's knowledge of firearms and their history far outweigh these points, and his spotlight on the present-day status of Mauser supply is, alone, worth far more than the price.—F. W. F. GLEASON.

KINGSBURY, A VENTURE IN TEAMWORK. By William P. Vogel, Jr. La Porte: Todd & Brown, Inc.

THIS book recaptures with a high degree of fidelity that period of the war during which industry and Government, working together, achieved peak production from our industrial machine.

The Kingsbury Ordnance Plant (La Porte, Ind.), operated by Todd & Brown, Inc., of New York, was one of our great shell-loading plants. As one of the seventy-three Government-owned, contractor-operated ordnance establishments, its story is representative of how we organized our strength for war and miraculously made up for the lack of time we had for preparation.

LOOKING FOR SOMETHING SPECIAL IN A 400 CYCLE MOTOR?



MODEL J37

EAD

SPECIAL DESIGN DIVISION HAS IT...

OR WILL ENGINEER AND BUILD IT

115 volts, 400 cycles, Motor-generator set. 2-phase servo motor drives induction generator. 400 cycle output voltage varies with frequency. MODEL J37 illustrated above has been used for anticipatory control of electronic servo systems.

EASTERN AIR DEVICES, INC.
136 FLATBUSH AVENUE
BROOKLYN 17, NEW YORK

CLIMAX MOLYBDENUM COMPANY

Producers of

"CALCIUM MOLYBDATE"
MOLYBDIC OXIDE BRIQUETTES
FERROMOLYBDENUM

Climax furnishes authoritative engineering data on molybdenum applications

•

CLIMAX MOLYBDENUM COMPANY
500 Fifth Avenue • New York City

KENWORTH

heavy duty trucks and buses

KW

KENWORTH MOTOR TRUCK CORPORATION
Factory and Home Office: 8801 East Marginal Way, Seattle 11, Washington

For 100 to 150 lb. Weighing Jobs..

General Industry has great need for weighing equipment in the 100- to 150-lb. bracket. After close study of the problem we have designed and built EXACT WEIGHT Scale # 1120 (illustrated) to meet this demand. This unit solves the leading objections field men have complained about in many heavy-duty scales available to them. The new EXACT WEIGHT Model # 1120 features: a low weighing platform (6½" from floor); open construction which makes scale easy to clean; inclined tower at 30 degrees, revolves to face any direction; dial 16 ozs., over and underweight; speed due to short platter fall; weighs accurately on any kind of floor; aluminum construction, three times lighter than cast iron. Write for complete specifications.

INDUSTRIAL PRECISION
Exact Weight Scales

THE EXACT WEIGHT SCALE COMPANY
West Fifth Avenue, Columbus 8, Ohio
Dept. W, 783 Yonge St., Toronto 5, Canada

KEARNEY & TRECKER
CORPORATION
Milwaukee
MILLING MACHINES

Manufacturers of Milwaukee Milling Machines

THE SEAL OF THE ARMY ORDNANCE ASSOCIATION

A wall plaque made of pressed wood in the traditional colors—shield in maroon, device in bronze. A pleasing decoration in office, library, etc. Size 8 x 9 inches. For sale to members only. Three dollars, boxed; postage to domestic destinations included. Prompt delivery. Send orders with remittance to

THE ARMY ORDNANCE ASSOCIATION
705 Mills Building **Washington 6, D. C.**

Book Reviews

As a first-published history of a war plant, it is an excellent and interesting addition to the published accounts of the war years. Mr. Vogel, a former associate editor of *Fortune* magazine, has not only told an industrial story with high technical competence but has also portrayed a moving account of the managers, people, and machines of a war plant. In the years to come, such a record will grow in importance and value.—HOWARD PRAEGER.

BATTLE STUDIES. By Col. Ardant du Picq. Harrisburg: Military Service Publishing Company. 273 pp. $2.

THIS famous book on the psychology of battle was written almost three-quarters of a century ago by an obscure French colonel. It is a luminous statement of the principles of combat, and it will be difficult to find a better analysis of the human element in warfare than in these pages.

The book is divided into two parts. Part I treats of man in primitive and ancient combat and analyzes some of the classical battles of antiquity. Part II discusses the material and moral elements of modern warfare and the rôles played by the infantry, artillery, cavalry, and command and general staff group. A voluminous appendix includes a memorandum on infantry fire and a number of historical documents.—R. E. LEWIS.

MANNLICHER RIFLES AND PISTOLS. By Walter H. B. Smith. Harrisburg: The Military Service Publishing Company. 239 pp. $5.

THIS book is one of a series written by Walter Smith devoted to bringing to the gun enthusiast information on the products of Ferdinand Ritter von Mannlicher, a staunch Austrian patriot and a mechanical genius. He was a prolific inventor of firearms, and many of his inventions were so far ahead of their time that they were not fully appreciated by military leaders of that day.

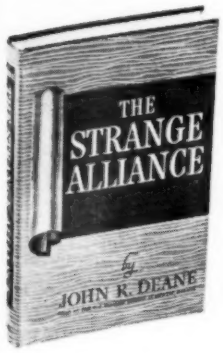
The author has taken available information and drawings from the great Austrian Steyr Works, prime manufacturers of all the Mannlicher weapons, together with data from minor manufacturers such as Haenel and lesser known German works at Suhl. This information has been used to prepare this interesting book which is exceedingly free of error, both as to factual material and typographical make-up. A study of the line drawings together with the descriptive matter will enable the arms student to fully comprehend these fine weapons.

Although more detailed description would have been desirable in some instances, the book is highly recommended to persons interested in European arms as it presents information never before available.—H. E. STIER.

HUNTING BIG GAME (Vol. I, In Africa and Asia, 339 pp.; Vol. II, In the Americas, 282 pp.). Edited by Townsend Whelen. Harrisburg: The Military Service Publishing Company. $4 the volume, $8 the set.

THE name of Col. Townsend Whelen, stalwart American gunner, just about guarantees the caliber of any anthology which he edits. And this one is most generously edited for, in addition to his selection of the twelve hunter-authors (all of whom were empire builders, statesmen, explorers, or naturalists of note), he has written introductions to each volume, to all but one of the authors, and to many of the subsections. He has written the entire chapter on Panama jungles and many other notes.

"Hunting Big Game" is a collection of adventure stories that will keep any normal male thrilled for a solid week and is a guide to outdoor life and gunnery to delight the mind and heart of the sportsman. When to all this is added the geography and natural history of three continents and the Arctic, no member of the fraternity can afford to be without this literary treat.—F. W. F. GLEASON.



The Army Ordnance Association Book of the Month for May

The STRANGE ALLIANCE

The Story of Our Efforts at Wartime Coöperation with Russia

By John R. Deane

This is General Deane's account of his assignment as head of our wartime military mission to Russia—of the difficulties, the successes which attended his work, of obstacles, frustration—the whole record of the secret happenings in Russia and in our Russian relations from 1943 to 1945.

Retail price $3.75 To members $3.19

THE MEETING OF EAST AND WEST

By F. S. C. Northrop

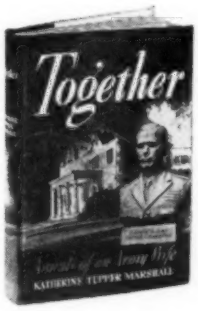
A magnificent study of the philosophies of the East and West—a book which *Time* says may well change the course of history. Retail price $6.00 To members $5.10

AMERICAN MILITARY GOVERNMENT

By Dr. Hajo Holborn

A study of the organization and policies of American military government, with appendices reproducing documents on which our administration of military government is based.

Retail price $3.50 To members $2.97



TOGETHER

By Katherine Tupper Marshall

Best-selling study of Gen. George C. Marshall, our new Secretary of State—acclaimed all over the country as top-rank writing and fascinating biography. A book which can be read and reread for years.

Retail price $3.50 To members $2.97

THE NEW TESTAMENT

By Msgr. Ronald Knox

A new translation by Monsignor Knox—hailed as an achievement in English literature.

Retail price $5.00 To members $4.25

JOMINI'S ART OF WAR

Edited by Lieut. Col. J. D. Hittle

A brilliant condensation of Jomini's military classic. Jomini, overshadowed by Clausewitz, remains a vital commentator on the art of war in all its aspects.

Retail $2.50 To members $2.13

THE INDUSTRY-ORDNANCE TEAM

By Lieut. Gen. Levin H. Campbell, Jr.

The definitive story of a magnificent achievement in coöperation and production during World War II.

Retail $5.00 To members $4.00

THE FUTURE OF AMERICAN SECRET INTELLIGENCE

By George S. Pettee

Dr. Pettee examines the deficiencies in our present and past operation of strategic intelligence, and the organization, the methods, the doctrine which we need to ensure our future security.

Retail price $2.00 To members $1.70

ARMY ORDNANCE ASSOCIATION
705 Mills Building, 17th & Penna. Ave., N.W., Washington 6, D. C.

Gentlemen:

I enclose $ . . . . . Please send me the following books:

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Name (PLEASE PRINT) . . . . . .

Address . . . . . .

City, Zone, State . . . . . .

Prepublication Announcement from the

Ordnance Book Service

"WEAPONS OF WORLD WAR II"

By Maj. Gen. G. M. Barnes

A limited number of copies of this great new book (345 pages, 244 illustrations) will be available upon publication to members of the Army Ordnance Association at a saving of $1.25 over the retail price. Save this money by ordering NOW for delivery within 30 days.

The author, Maj. Gen. G. M. Barnes, U.S.A. (Ret.), served 36 years with high distinction in the Regular Army. Most of this period of brilliant achievement was devoted to research and development in the field of ordnance.

GENERAL BARNES

In this highly informative and fascinating volume, General Barnes fully and expertly describes the weapons developed and utilized during World War II, including machine guns, artillery, aircraft armament, bombs, tanks, antiaircraft artillery, and many other superb weapons.

The book contains 345 pages and approximately 244 halftone illustrations. It will delight all arms enthusiasts and especially those who designed, produced, or used the superior Ordnance weapons and combat equipment that played such a major rôle in achieving victory in World War II.

Retail price $7.50 **To members $6.25**

THE ARMY ORDNANCE ASSOCIATION

ORDNANCE BOOK SERVICE,
ARMY ORDNANCE ASSOCIATION,
705 Mills Building,
Washington 6, D. C.

Gentlemen:

I understand that General Barnes' new book, "Weapons of World War II," will be available to A.O.A. members at $6.25. This saving of $1.25 over the retail price of $7.50 will be granted to members who order their copies now for delivery about June 15, 1947.

I enclose $..... for ..... copies.

Name (*please print*) .....

Street .....

City, Zone, State .....

Book Reviews

CÆSAR'S GALLIC CAMPAIGNS. By Lieut. Col. S. G. Brady. Harrisburg: Military Service Publishing Company. 230 pp. $2.50.

HERE is a new version of Cæsar's immemorial conquest of Gaul. A surpassing military genius, outstanding statesman, and superb historian, it is no wonder that the study of his military campaigns should continue in popularity to the present day.

Himself a military man and Latinist of distinction, Colonel Brady had contributed a new, compact, and sprightly rendition of the Commentaries. Sufficiently precise for most requirements, Colonel Brady has achieved a modern, easily read style in rewriting this famous classic.—ROBERT EMSWORTH.

REMINGTON HANDGUNS. By Charles Lee Karr, Jr., and Carrol Robbins Karr. Harrisburg: The Military Service Publishing Company. $5.

THIS is another of the series of National Rifle Association Library books and, from this reviewer's study, is the best to date. Nothing can be added to the comments of Lieut. Col. Calvin Goddard in his introduction that it "represents one more foundation stone in the edifice which is the story of handguns in America. It is a sturdy block, carefully hewn and polished, and the two workmen who quarried and laid it have produced a job which is plumb, square, and level."

The small volume of 125 pages contains a full, complete, and accurate description of the Remington line of handguns, with illustrations which leave no doubt in identification of various models to even the novice. The material is outstandingly useful to the advanced student who is aided by the model chronological index and bibliography.—H. E. STIER.

HOW TO HUNT AMERICAN GAME: A GRASS-ROOTS GUIDE TO AMERICAN HUNTING. By Robert B. Vale. Harrisburg: Military Service Publishing Company. 199 pp. $4.

"GRASS ROOTS" is indeed a most apt term to describe this practical volume. In it the author has condensed forty years of hunting experience and wild-life lore. His approach is distinctly toward the furred and feathered game rather than toward the tools of hunting, and the book is not a work of the "gun" type.

In this respect it is rather a welcome relief from the succession of purported hunting guides which all too often turn out to be catalogues of shotguns, rifles, and accessories without being true studies of firearms. Vale places all the emphasis on knowing the particular game being sought and developing the ability to find and to stalk it. Too many of today's "hunters" invest in super-velocity guns, infra-pink-television scopes, and other trick doodads—then open rapid fire at extreme range, bagging a cow or a farmer in the next county!—F. W. F. GLEASON.

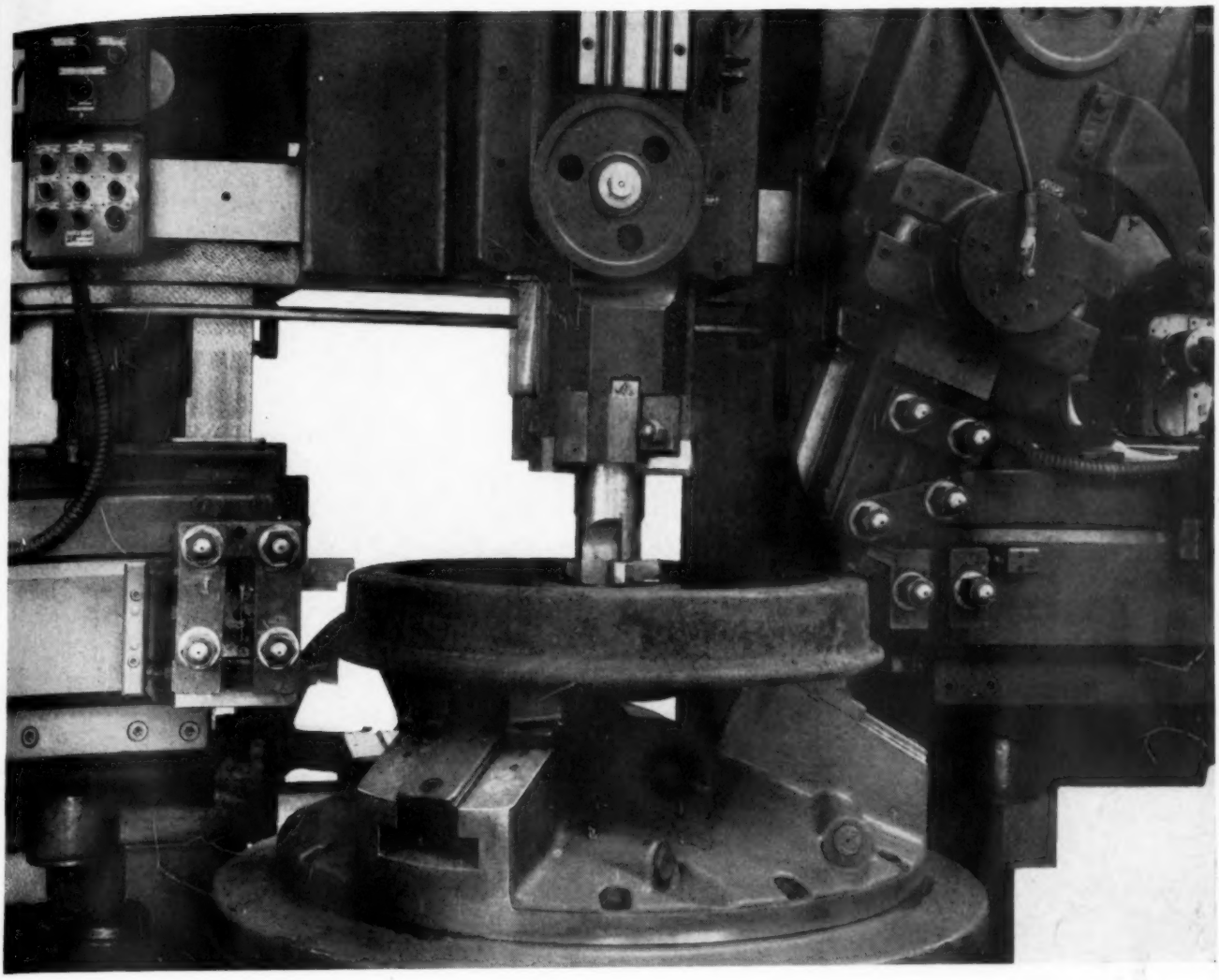
THE HARVEY METAL CORPORATION

Engineers and Manufacturers

SMOOTH FORGED

BRASS, COPPER and ALUMINUM

CHICAGO, ILL.



New TIMKEN BEARING EQUIPPED Machine Revolutionizes Railroad Car Wheel Finishing

Thanks to this remarkable postwar development of the Cincinnati Planer Company, Cincinnati, Ohio, rolled steel car wheels now can be completely machined at the rate of approximately six wheels per hour — a considerable reduction in production time and cost.

An ingenious new chucking device assures quicker setting and accurate centering of the wheel and permits boring of the center hole simultaneously with the machining of the rim, flange and tread, resulting in a better balanced, better finished wheel.

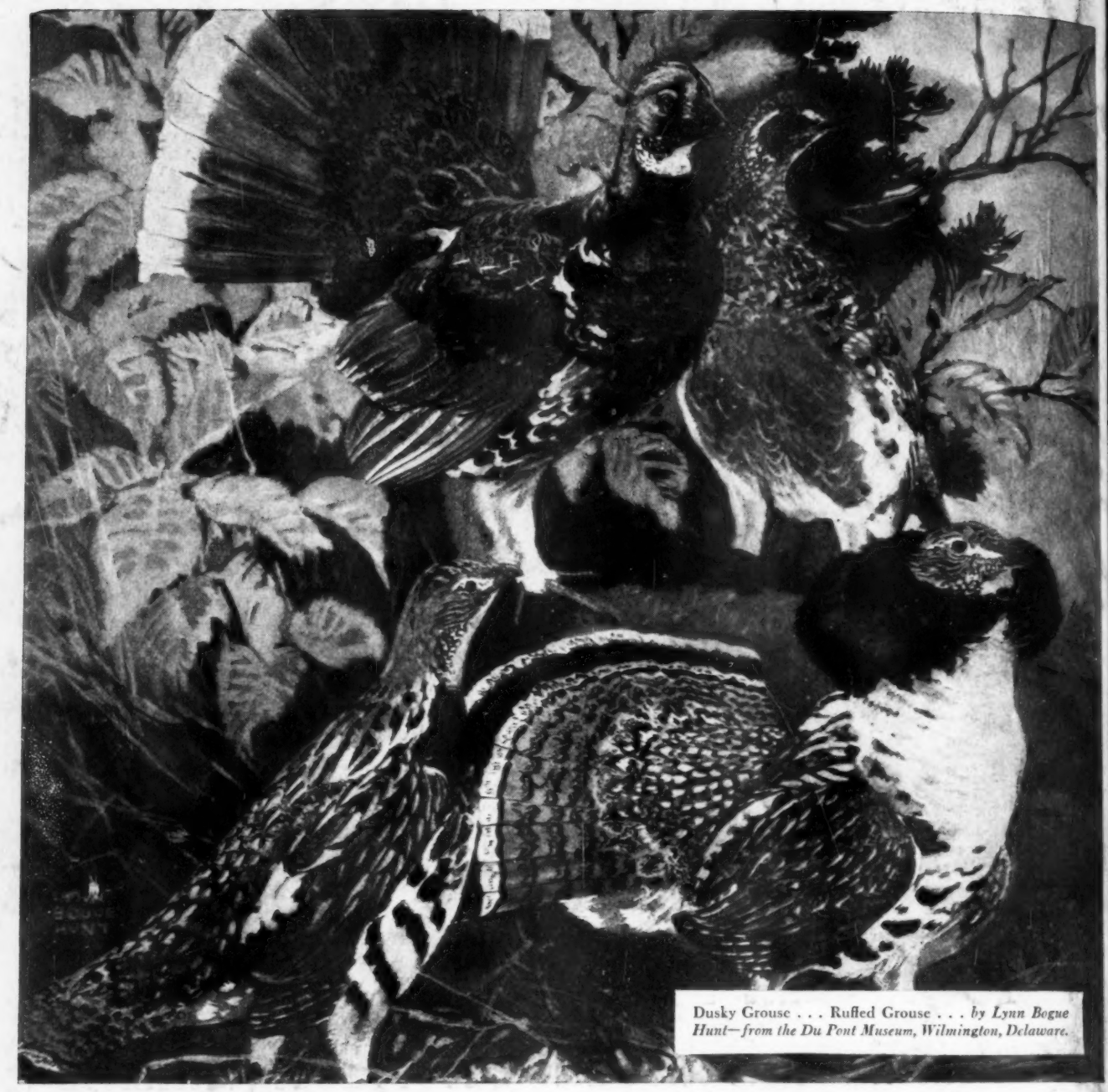
Prominent among the provisions for precision, dependability, endurance and low maintenance are 19 Timken Tapered Roller Bearings applied on the input shaft, bevel gear shaft, table drive shaft, clutch shaft, spindle, rail head pinion and rail drive idler.

Any machine is a better machine when it is Timken Bearing Equipped, as thousands of manufacturers and users have proved. Look for the trade-mark "TIMKEN" on every bearing that goes in your equipment. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TAPERED ROLLER BEARINGS

48 YEARS OF ENGINEERING AND METALLURGICAL DEVELOPMENT



Dusky Grouse . . . Ruffed Grouse . . . *by Lynn Bogue Hunt—from the Du Pont Museum, Wilmington, Delaware.*

How to Find More Game Next Year

This year, the game supply is below normal in many localities. Yet there are more shooters today than ever before. Next year, and in the years to come, there may be more game for you and for all if today, when you go hunting, you limit your bag. Help also by joining and supporting local and national organizations for game restoration and conservation.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Explosives Department
Wilmington 98, Delaware

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

DU PONT SPORTING POWDERS

WORLD-FAMOUS SINCE 1802